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By J. RUSSELL SMITH

*Professor of Industry in the Wharton School of Finance and Commerce
of the University of Pennsylvania*

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THE SCIENTIFIC MONTHLY

MAY, 1916

THE EVOLUTION OF THE EARTH¹

I. EARTH-GENESIS

BY PROFESSOR THOMAS CHROWDER CHAMBERLIN
THE UNIVERSITY OF CHICAGO

THE evolution of the earth is but the domestic chapter of the evolution of the heavens. In the great volume that records the history of the stellar galaxy no doubt there are a multitude of little chapters of planetary evolution. It is our task merely to tell the story of our own planet. The evolution of other planetary systems may not always have followed the same lines. No doubt many agencies are concerned in the evolution of the bodies that attend the stars. Quite different methods may have given rise to these attendants. It is our task to detail, if we may, the particular way in which our planet and its kindred planets came into being.

The qualities inherited by the earth from the mode of its birth very likely carried into all its subsequent history influences of high potency. Unless we detect the essential nature of these at the start, we will quite surely go astray in the interpretation of the events that followed. It is scarcely less than imperative that we dwell with some care on the initial stages.

Our method must be that of the naturalist—the geo-naturalist, the cosmo-naturalist; it must be an endeavor to find in the features of the earth and of the planetary system the autobiographic story of the planet's experiences recorded automatically in planetary language.

There was a time when mankind very generally was wont to treat with levity the endeavors of geologic pioneers to read the ancient history of the earth from its automatic record. But those days have passed; the intelligent world to-day accepts with confidence the story of the earth's history as it is read in strata, in life relics, in water-marks, in the necks of ancient volcanoes, and in the stumps of vanished mountains. The world recognizes and respects the lithographic story that

¹ Third series of lectures on the William Ellery Hale foundation, National Academy of Sciences, delivered at the meeting of the academy at Washington, on April 19-21, 1915.

tells—with incompleteness, to be sure, but with great fidelity—the history of the earth reaching back for perhaps a hundred million years.

Back of that, even the scientific world is still wont to regard the story of our planet as falling into obscurity, for the lithographic scriptures cease to be fully legible with the Paleozoic terranes, and with the lowest Archean, the whole lithographic record becomes inaccessible. We are wont to assume that because this lithographic record has failed us, there is no other record to which we may have recourse. But there are dynamic vestiges of creation as well as lithographic vestiges, and some of these dynamic vestiges bear witness to the much earlier stages of terrestrial history, reaching back even to the earth's nativity. We may say with confidence that these dynamic vestiges tell the story of its birth; we may not say with equal confidence that we have read the story aright, or that it can as yet be read aright; we may merely say with confidence that the story is thus recorded. The reading of dynamic records presents inherent difficulties; we are but scantily familiar with such literature; but the record is none the less sure; certain dynamic records are even more instructive than lithographic inscriptions.

Our planetary system records itself as a group of bodies circling about their controlling star, the sun, in ways that are full of meaning. There are singular relationships one to another; there are remarkable symmetries and departures from symmetries; these relationships tell the story of the kinship of the planets to one another, and their kinship to the sun. In some large measure—whether we can yet read it aright or not—they tell the story of the planetary births. They even tell vital facts of planetary history. The harmony in the planetary family is such as to make it quite sure that throughout its whole history it has never been seriously perturbed by external influences. Such are the peculiarities and the symmetries of the planetary organization that it is fairly safe to say that during its existence, be it a hundred million years—or ten hundred million years, if you please—the system has never been so near to another body of stellar massiveness as to suffer serious disturbance of its internal relationships. If the solar system had ever been within a billion miles of another body of the mass of our sun, the record of that approach would appear in the dynamic vestiges of the system as it is seen to-day.

In this record of internal harmony, this record of an undisturbed career, there lies a guiding suggestiveness that may not appear on first statement. The center of the system is moving through space at the present time at about nineteen kilometers per second; around this center, as it speeds through space the members of the planetary family circle in close attendance on their governing star. As a harmonious group they have thus swept a broad path throughout all the history of the system. The immensity of this sweep at once challenges the power of the imagi-

nation to picture such a vastness of space and such an openness of distribution of stars within it as to make possible an undisturbed journey of so broad a system.

So wide deployment of the stellar system implies energies and movements of a stupendous type. These constituted the dynamic environment of the earth's nativity. The nature of these stupendous energies and the laws of these vast activities may serve as our guide in a search for the conditions of planetary birth.

We may at once catch a hint of no little value. The massive center of the solar system is moving among the stars at the notable rate of nineteen kilometers per second; the earth is circling about it at the higher rate of thirty kilometers per second and yet is attending it in its journey through space. The earth pursues a spiral path of notably greater length than the path of the sun. We ourselves on its surface sweep around the earth with its rotation and describe a more tortuous, a longer and a swifter path than the center of the earth itself. The molecules of the atmosphere fly to and fro with prodigious rapidity while they accompany us in our tortuous course; in their still more devious paths they are moving much faster than we. If you will recall the initial lecture of this series by Sir Ernest Rutherford, it will bring to mind particles whose velocities are prodigious, even when compared with the swiftest of the swift celestial movements. Out of this comparative series we may catch a glimpse of the law that the smaller bodies of celestial space move more swiftly than the larger bodies, as a general rule; a law inherent in the nature of the case, a law founded on the natural workings of the principle of the partition of energy.

The suggestions of this law are adverse to those inherited ideas which associate inertness with scattered matter; which assign it the lazy habit of "floating in space," which assume that it may slowly assemble. These seem to be inheritances from the picture of primeval chaos. Quite the contrary, it would seem that the little bodies and the scattered matter are the most active of the active in the celestial world. No vestige of chaotic inertness seems to be found either in observation or in good theory.

The vast deployment of the stars implied by the long swift journey of our system among them teaches us at the same time of the immensity of the celestial energy that actuates the vast moving assemblage. We are accustomed to look to the stars themselves as the great sources of energy—and their radiant output is indeed prodigious—but the motion of the stars themselves is an expression of greater energy than is their radiance, while the deployment of the stars involves potential energies which are a high multiple of both these other great sources combined. And then there are the unmeasured resources of radioactivity.

These general observations are but a means of catching some glimpse

of the environment which encompassed the nativity of the earth and contributed to its endowment. These prodigious sources of energy, the radiant activities, the inertia of stellar movement, the potential energies of deployment, and the occult energies of atomic dissociation combined to endow the earth with those energies that have actuated it during its prolonged history. In the vast openness of heaven, amid its intense activities, and partaking of its prodigious energies, the earth appears to have had its birth.

There are two contrasted types of hypotheses of the origin of the earth and of its kindred planets. The one class have taken for their start the assumption that the parent matter was already widely dispersed in space. They have contented themselves with simply endeavoring to interpret the segregation that followed. They have been content with one half the story. The other class have felt the obligation first to find adequate agencies by which the requisite matter might have been deployed, and then, from that deployment, and in full consistency with it, have endeavored to interpret the mode of its reaggregation into a new system. These hypotheses endeavor to recognize the forerunning destructive factor as well as the sequent constructive factor. They thus try to decipher the whole story; starting from a beginning in conditions such as exist in the heavens to-day, they try to trace the evolution on to an end like that presented by the earth and its kindred as we now find them.

To the first type belongs the most ancient genetic concept that has come down to us, an evolution from primeval chaos. If I have been so fortunate as to impress what seem to me the most essential conditions that dominated the celestial environment at the time of the earth's birth, there will be little need to dwell upon any idea inherited from the ancestral picture of primeval chaos. The ancient idea of chaotic inertness, of mere passive susceptibility of segregation, awaiting endowment with exotic force, seems to have no warrant in anything now observable in the stellar universe. If the picture of primeval chaos were ever true, it would seem that its day must have lain far back of the birthday of the earth.

The hypotheses that have commanded the largest assent during the past century have usually started with assumptions somewhat akin to the ancient concept of chaos, but yet distinctly removed from it by postulating conditions and endowments akin to those supposed to reside in the dispersed states of matter now seen in the heavens. The task that these hypotheses set themselves was the delineation of the course of transformation from a postulated nebulous state into an organized planetary state, a process at once of nebulous partition and of nebulous concentration. The segregative work was assigned chiefly to gravitation; the partitive work, the separation of matter to form the individual

planets, was chiefly assigned to centrifugal action. In the brevity enforced by the limits of the hour, it will be convenient to group all such hypotheses into a centrifugal genus. The essential feature of this genus lay in the assigned tendency of the nebulous matter to concentrate itself until its velocity of rotation set off certain parts which later condensed into planets, planetoids and satellites. To be consistent, every hypothesis belonging to this genus, whatever its special terms, must stand the test of a fair accord with the criteria that inevitably attend the results of centrifugal action. The parts set off by such action should lie somewhat accurately in the plane of the equator of the body that set them off, the sun. The sun itself must retain a rotatory velocity in keeping with its assumed competency to shed matter in this way. How does the centrifugal hypothesis stand these critical tests? The earth is now revolving around the sun at thirty kilometers per second. If it were set off by centrifugal action at this distance from the center of the system, the rim of the rotating mass should have then moved at this notable velocity of eighteen miles per second. When the parent mass shrank to the orbit of the innermost planet, Mercury, it should have had an equatorial velocity of nearly fifty kilometers per second. The rotation should have further increased with further contraction. If the rotation of the sun were competent to cast off masses from its equator with its present dimensions, it should have a velocity of 435 kilometers per second. As a matter of fact, it has a velocity of about two kilometers per second. Here is a grave discrepancy. The sun's equatorial velocity is scarcely a two-hundredth part of what is required to discharge matter centrifugally from its present surface.

The equatorial plane of the sun is inclined to the orbit of the earth; by the hypothesis, the matter of the earth should have been shed quite accurately in the sun's equatorial plane. This plane is also inclined to the orbital planes of each one of the planets. More significant still, it is inclined to the invariable plane of the planetary system which represents the dynamic summation of the planes of all the planets. The inclinations, to be sure, are not great, the earth's orbital plane being inclined $7^{\circ} 15'$ to the equatorial plane of the sun; but when the prodigious inertia of the planetary movements is taken into account, even this variation is a notable discrepancy; perhaps it is not a fatal discrepancy in itself, but it adds to the gravity of the great rotational discrepancy. If, as one of the incidents of the generation of the new planetary system, the sun's rotation was reversed, as seems not improbable from the remarkable slowness of the sun's present rotation and the inclination of its axis, its original inclination would be as large as an exacting application of the law of probabilities would demand.

The rotational discrepancies are not confined to the simple facts of slowness and inclination. If the rotational value of the sun were in-

creased by the accession of all the planetary bodies carrying into it all their momentum values, with the consequent acceleration of its velocity, it would still be incompetent to discharge from its surface centrifugally the several planets in their places. The elaborate investigations of Dr. Moulton have placed this upon a specific and invulnerable basis. The discrepancies disclosed at the several stages of the postulated evolution range from disparities of 140:1 up to 1,800:1.

So also, there are discrepancies between the masses of the several planets and the momenta they should carry under a systematic process of centrifugal separation. If the postulated nebula at the time it was, by hypothesis, preparing to shed the great planet Jupiter, be restored, every layman more or less familiar with mechanical laws may estimate for himself, in some rough way, at least, the relative value of the rotatory momentum carried by the whole body and by an equatorial rim of one-thousandth part of the body, respectively, making all due allowance for the fact that the momentum of the outer part has a higher value than that of any similar part within, not only because it moves faster, but also because it moves on a longer arm. The mass of Jupiter and his moons taken together is somewhat less than a thousandth part of the mass of the postulated nebula at the time the separation of the supposed Jovian ring took place. Now if one has formed such a rough estimate one will be ready to appreciate the meaning of the fact that Jupiter actually carries more than 96 per cent. of the total value of the rotatory momentum of the nebula at the time of its assigned partition, while the 999 parts left behind by hypothesis carry only the remaining four per cent. The sun itself, massive as it is, now carries only about two per cent. of the momentum values of the whole planetary system, while 98 per cent. is carried in the attendant bodies, and yet the total mass of these attendant bodies is only about $1/745$ of the solar mass. That such are not the proportions that would arise from a systematic separation of the planets from a parent nebula by centrifugal action is quite clear even on simple inspection; it may be confirmed by computation, which shows that there are even more remarkable discrepancies in the cases of some other planets.

A very slight portion of these discrepancies may be referred to tidal action, but the computations of Sir George Darwin show that this amelioration is extremely trivial.

There are other striking discrepancies. If the centrifugal mode of planetary separation obtained in the solar system, the planets should take less time to rotate upon their axes than the satellites to swing around them at some distance, and yet Phobos, the little inner satellite of Mars, sweeps around the planet about three times while the planet rolls around once. Moulton has pointed out, also, that the little bodies that make up the inner side of the inner ring of Saturn circle around

that planet about twice while the planet rotates once. If tidal friction is appealed to as a means of bringing these into consistency, it is found available, as Dr. Moulton has shown, only if one of these cases is three thousand times as old as the other.

It is a necessary inference that satellites, shed centrifugally, should rotate in the same direction as the planet from which they were cast off; and yet it has recently been discovered that one of the satellites of Saturn rotates in a direction contrary to the planet and its eight other satellites. Still more recently it has been discovered that two of the satellites of Jupiter disregard the family habit in a similar fashion. This behavior seems fatally inconsistent with a centrifugal origin.

If we turn to the heavens for their testimony, none of the many thousands of nebulae show a concentric system of symmetrical circular rings, fulfilling the postulates of the hypothesis. Figs. 1, 2, 3 and 4 are introduced to show such imperfect degrees of approach to conformity with this hypothesis as are presented.

The foregoing formidable series of grave discrepancies, conjoined with this lack of convincing illustrations of centrifugal evolution in progress among the many thousands of nebulae now known, seem to require us to set aside the whole centrifugal genus of genetic hypotheses, including as its foremost exponent the venerable hypothesis of Laplace—so far, at least, as the genesis of our planetary system is concerned. We may not do this without a recognition of the profound stimulus that these hypotheses have given to inquiry into the origin of the solar system during the past century.

The hypotheses that have commonly been called meteoritic have usually been built up on a structural or textural basis rather than a dynamic one. They have been rather theories of the constitution of nebulae than theories of the origin of the earth. They have not been worked out into the specific details of separation and followed out through all concentrative processes down to the stages of the existing planets. They do not, therefore, lend themselves readily to brief discussion. As theories of the constitution of nebulae they have not been sustained by progressive inquiry.

In so far as supposed meteoritic assemblages constitute swarms and are actuated by collision and rebound in quasi-gaseous fashion, as developed by Sir George Darwin, they are subject to the grave difficulties we have just cited against the more familiar gaseous forms of the centrifugal genus.

In so far as the postulated meteorites are supposed to pursue individual orbits, a series of difficulties of a different type are encountered. The precise form of these difficulties varies according to the specific form given the hypothesis. If the planes of revolution of the individual meteorites lie in various directions, as is natural in a heterogeneous

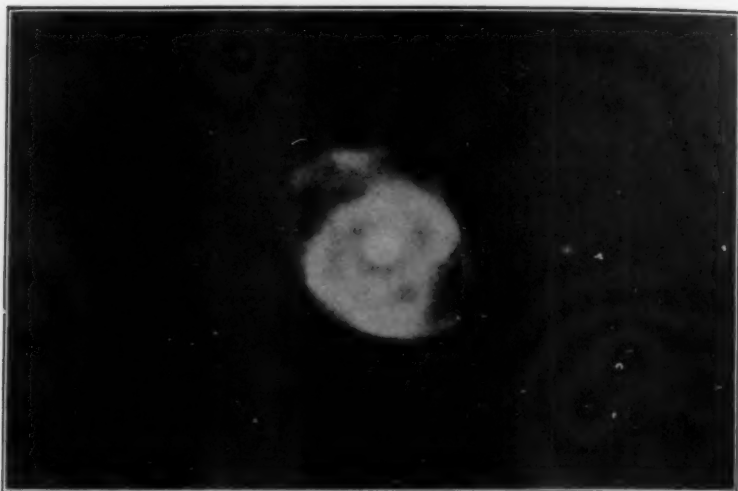


FIG. 1. NEBULA N. G. C. 6543, DRACO, PLANETARY. Spectrum, bright lines on a continuous background. Photo from Mt. Wilson Solar Observatory. Note apparent absence of gradation and hydrostatic support.

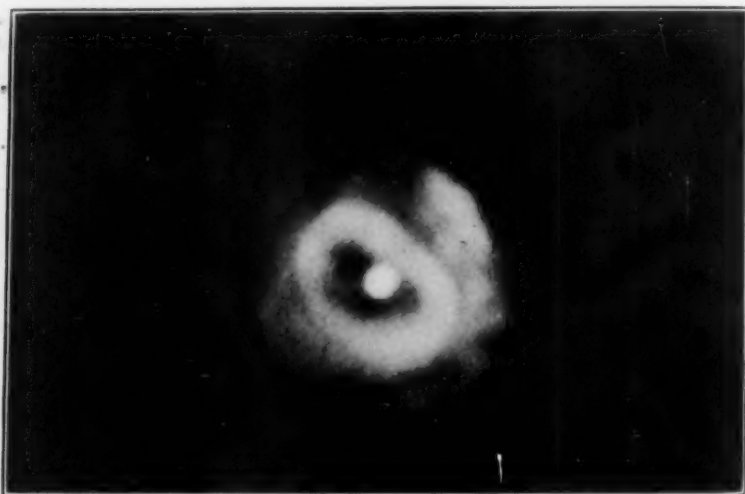


FIG. 2. NEBULA N. G. C. 7662 (H IV 18). The Andromeda planetary. Photo from Mt. Wilson Solar Observatory.

assemblage, the concentration tends toward globularity, whereas our planetary system is pronouncedly discoidal. The difficulties of assigning a globular cluster of revolving meteorites such a system of dynamics as shall cause them to evolve naturally into a highly discoidal system of revolutions, with 98 per cent. of the moment of momentum concentrated

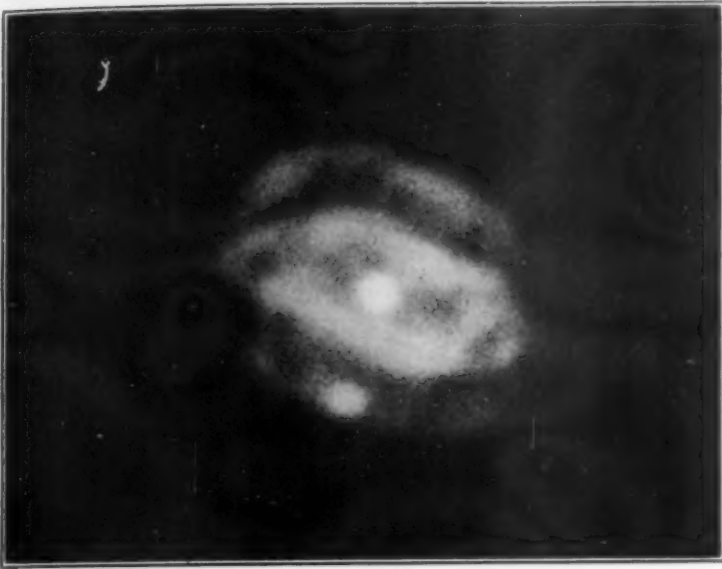


FIG. 3. NEBULA N. G. C. 7009. "Saturnian" planetary. Note the faint "ansæ" in the extrusion of the major axis. Photo from Mt. Wilson Solar Observatory.

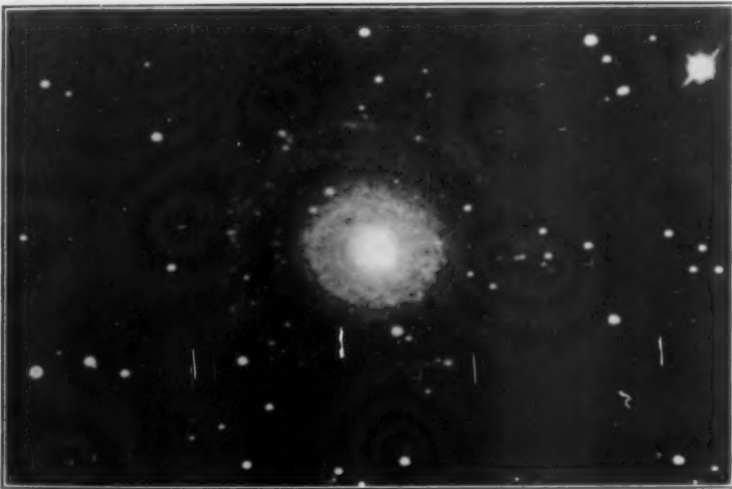


FIG. 4. NEBULA N. G. C. 7217 (H II 207). Note the knotted structure and the faint oblique spiraloid tracts. Photo from Mt. Wilson Solar Observatory.

in 1/745 of the outlying material, are very grave. The difficulties of aggregating sparsely scattered revolutionary meteorites, highly endowed

with momentum, into a few large planets, without special collecting centers, are also grave.

There is an inherent difficulty in assigning any competent aggregative tendency to meteorites as such, if we may judge from the dynamics of those within reach of observation. With their observed velocities their momentum is extremely high relative to their attractive power. The individual attractive power of an average meteorite is almost immeasurably feeble. The sum total of attraction of a great swarm of meteorites, if such exist, might indeed be high, but it is an attraction toward the common center, not toward outlying points where the planets must grow up. In and of themselves, meteorites are controlled by a dispersive rather than a concentrative tendency. It is only by starting with the *assumption* of an enormous assemblage whose initial gravity is sufficient to hold the individual meteorites under control, that it is possible to proceed rationally at all, and then the concentration is presumably toward the common center of gravity and not toward outlying planetary centers.

If the difficulties of a definite segregation into a few large planets revolving in a sharply appressed disk have been met at all under the meteoric hypothesis, it has been rather by a tacit assumption of the appropriate concentrations than by the assignment of specific reasons for such an aggregation. But concentration must already have gone far before it comes to have much aggregating force. Even the full-grown earth has relatively little power to swerve the meteorites from their paths. It collects them, to a trivial extent, chiefly because it lies in their path, not because it is a controlling center for their aggregation; their velocities are too great for effective concentration. The earth can not control a velocity so great as seven miles per second, while the average velocity of meteorites relative to the earth seems to be three or four times that. In the absence of effective collecting centers the mutual collisions of meteorites moving at observed rates would result in fragmentation and still more minute dispersion. This is, with little doubt, the reason why most meteorites are so small, and why their habits are so pronouncedly dispersive. They are food for the scant feeding of massive bodies already formed, but they are deficient in formative power themselves.

The foregoing are at best but half-hypotheses. They start with assumptions of certain kinds of nebulae already formed and merely try to trace the evolution of these into a planetary system. The more complete classes of genetic hypotheses endeavor to go back to the beginning of the dispersion that prepared the way for reaggregation into a new system. They thus try to tell the whole story. This broader endeavor early found a representative in a theory quite as venerable as the hypotheses of Kant or Laplace, but unfortunately it is not worthy of serious consideration as a specific explanation of the origin of our planetary system. It is

merely representative. More than a century ago the naturalist Buffon suggested that a comet might have collided with the edge of the sun and have driven off sufficient matter to form the planets. While this is obviously an untenable view, the dynamic concept of a glancing collision of one form or another between two bodies has been the basis of a series of hypotheses which may be grouped together as a collisional genus. This genus avoids some of the fundamental difficulties that lie so gravely against the preceding hypotheses. A collisional impact might leave the rotation of the sun as slow as it actually is. The collisional effect might obviously be accelerative or retardative according to the mode of stroke. By hypothesis the sun might have any possible velocity of rotation. The sun's axis might lie in any direction. So also, the matter driven from the edge of the sun might, by hypothesis, have all the momentum that any of the members of the planetary system possesses in perfect consistency with the sun's slow rotation and its oblique axis. It is no small merit in this genus of hypotheses to escape the fundamental difficulties of rotation and momentum that have proved to be so grave in the centrifugal genus.

But the collisional genus encounters, in its turn, certain formidable difficulties. In the first place, the mass of the sun, just before the collision, could not well have been less than it is now, and hence an approximate velocity may be assigned the collision. A body coming from without the sun's sphere of control would, neglecting any pre-existent velocity of its own, strike the edge of the sun at a velocity of the order of 600 kilometers per second, due to the sun's powerful attraction. If the body fell merely from some outer part of the sun's sphere of control, it still would have a velocity of a very high order of magnitude. If the sun's volume were larger at the time and the stroke took place farther from the sun's center of gravity, the velocity would indeed be lower; but still it would be high under any reasonable hypothesis of this type. To follow logically the consequences of such a glancing collision, it is necessary to give due weight to the violence of the encounter which these high velocities imply. The normal effect of such collisions would be a radial dispersion of both the striking and struck matter diverging from the point of encounter in various forward directions, except perhaps in such as were protected by the undispersed portions of the sun and of the colliding body; in other words, there should be a more or less fan-like radiation, with perhaps a truncated side representing the protecting effects. The two great nebulae of Orion (Fig. 5) seem, in some measure, at least, to fulfil these specifications. Normally the dispersion, under conditions so violent, would be extremely high. Nuclei for gathering together the dispersed matter into a few great planets would seem to be counterindicated by this, and the conditions for aggregation in any planetary form would apparently have been unpropitious.



FIG. 5. THE GREAT NEBULA OF ORION AND ITS COMPANION NEBULA. Bright line spectrum. Note evidences of special structure, absence of graded continuity and of hydrostatic support, in both nebulae. Photo from Yerkes Observatory.

But there is a more radical difficulty. Under the laws of mechanics, the dispersed matter driven off by the collision, if it were kept under control by the sun at all, must return to the point of collision and there be subject to a second collision, with a similar necessity of return and so on. Even if by some perturbation in the course of their outward or returning path, some of the dispersed matter were driven into new paths so that they escaped recollision, they must probably have assumed very eccentric and diverse orbits. The orbits of the planets do not present the characteristics that seem derivable from such sources. The orbits of all the planetary bodies are sub-circular, and they are distributed about

one another with a certain measure of symmetry that does not seem to be a normal product of such a marked asymmetry as would necessarily arise under the collisional hypothesis.

Thus this genus of hypotheses—whatever specific forms may be given the individual hypotheses under it—seems to have but a scant basis of acceptability. Without much question collisions occur in the heavens and evolutions must arise from the products of such encounters, and so the theory has its place in a general study of the evolution of the heavens. But grave difficulties lie in the way of supposing that a solar collision gave birth to our planetary system.

These four types of hypotheses, the chaotic, the centrifugal, the meteoritic, and the collisional, embrace essentially all that commanded much attention during the past century. Of these it is perhaps safe to say that the centrifugal genus, especially as represented by the Laplacian hypothesis, commanded more adherence than all the others combined.

There remains, however, another possibility, less obtrusive in its nature than any of these. For this reason perhaps it was more tardy in receiving consideration. It centers on *dynamic encounter*, that is, the dynamic effect which arises from the close approach of massive bodies without bodily collision. Its effects have certain of the qualities that arise from bodily collision but they are free from certain other qualities that give rise to grave difficulties in their application to our planetary system. While thus related to collision, dynamic encounter is radically distinguished from it. The approach is close only in an astronomical sense. It may range from the mere escape from collision up to a few millions, a few hundred millions, or a few billions of kilometers. The encounter is purely a dynamic one; it is an interpenetration of spheres of gravitative influence involving a contest for gravitative control.

If a star were alone in space it would be surrounded by an illimitable sphere of gravitative influence, strong near the star but declining rapidly as distance increased, yet never entirely disappearing, theoretically at least, within the bounds of space. If a second star were introduced at any point in space, the new gravitative influence would interpenetrate the previous sphere of influence; there would be both conflict and co-ordination of influence; the two stars would divide the previous sphere of control of the single star, each having its own sphere of dominance. If a multitude of stars occupy space—the actual case—their gravitative influences interpenetrate in a most intricate way, and yet about each star there remains a space within which its gravitative influence is greater than that of its rivals. Each star has its sphere of control; as does also each planet, planetoid and satellite.

Now it is to this conflict and coordination of stellar attractions that the genesis of the dominant class of nebulae, the spiral, is assigned. It

is to the evolution of a spiral nebula that the genesis of our planetary system is assigned.

Many years ago Roche showed by mathematical analysis that if a satellite be made to approach its primary on an in-running spiral, it will not retain its integrity until it reaches the surface of the primary but will be torn into fragments at a point 2.44 times the radius of the primary, provided the two bodies are homogeneous in density and all internal forces except gravity are neglected. If the density increases toward the center, the limit is larger. The Roche limit for the earth is about 18,000 kilometers; if the moon were to circle down toward the earth, it would be torn into fragments at about 11,000 miles from the earth's center. In being thus disrupted it would probably take on a form analogous to the fragmental clusters that are thought to form the heads of comets. The Roche principle with proper modifications is applicable to any celestial body approaching another on a curved path. If such approaching body has been greatly compressed previously by its own gravity, its internal elastic stress may greatly exceed its cohesion. In gaseous bodies, indeed, cohesion may be said not only to be absent, but to be replaced by repellancy which is only kept under control by the bodies' gravity. If the approaching bodies are great globes of gas, such as are the stars, and if they are subject also to powerful eruptive action, as is our sun, extraordinary effects may arise when a close swift approach is made on a more or less sharp curve, as such approaches always are.

Now imagine a star passing close to another star or massive body, pursuing necessarily a rather sharp curve at its point of closest approach and moving inevitably at very high speed; picture the enormous concentration of energy within such star arising from its molecular activity under its high gravitative compression; add to the picture the inherent eruptive tendencies that arise from this, if it belongs to the type of our sun, and it will furnish the working conditions of the case. Now imagine the interpenetration of the gravitative influences as the two bodies approach one another. Particularly note the way in which the gravity of the massive body penetrates, modifies and even neutralizes the gravitative control of the lesser body over its own substance, the force that had concentrated it into a globular form and strongly compressed it, and the picture will give the working elements for a concept of the prodigious eruptive and dispersive effects that will attend so simple an incident as a close approach. It is easiest to follow a case in which one body is much more massive than the other and is assumed to be so solid and non-explosive as to be little affected, so that the main response is limited to the minor explosive body. The action will be of the tidal type and follow tidal principles; indeed, it will be an extraordinary modification of a tidal process. Under such tidal action the star first becomes

elongated toward the passing body. The eruptions are then concentrated in the tidal cones. The ejections are shot toward and from the controlling body. The dispersive action constantly lies in the line of readjusted attractions between the centers of the two bodies. This line is constantly shifting its position; at the critical stage it is shifting rapidly; but this shift must always be in the plane of movement of the controlling body. It may be helpful to picture the elongated erupting star as a Janus-faced ordnance firing gaseous bolts fore and aft as it swings swiftly about its massive neighbor. The chains of missiles thus shot in opposite directions during the whirl naturally take on the form of two spiral curves as illustrated in Fig. 6. The two-armed feature of the

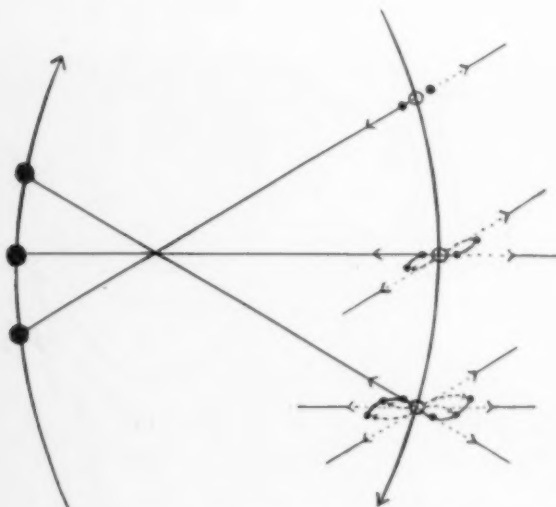
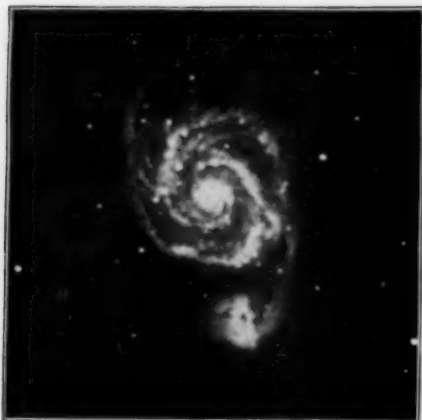


FIG. 6. DIAGRAM ILLUSTRATING A HYPOTHETICAL MODE OF FORMATION OF A SPIRAL NEBULA.

spiral which results is amply exemplified in the spiral nebula. A star with an inherent explosive habit passing near a massive body thus, by interpretation, is converted into a spiral nebula.

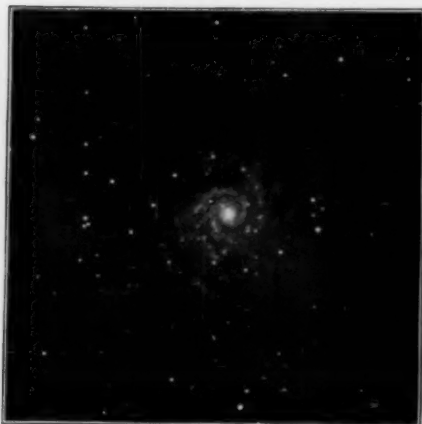
How large a portion of a given star will be shot forth into spiral arms depends on the closeness of approach, the elastic compression of the star, the massiveness of the passing body, and other factors. If the star passes within the Roche limit of the more massive body it may, theoretically at least, be entirely deployed into spiral arms, leaving little or no nucleus behind. If the approach be less near, the residual nucleus will be correspondingly larger. A series may thus be formed which grades from the most dispersed forms in which spiral arms preponderate with almost no nucleus, up through spirals with greater and greater



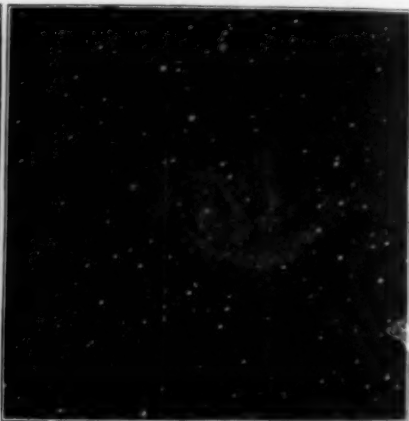
1. M 51 Can. Ven. = N. G. C. 3572-3574.



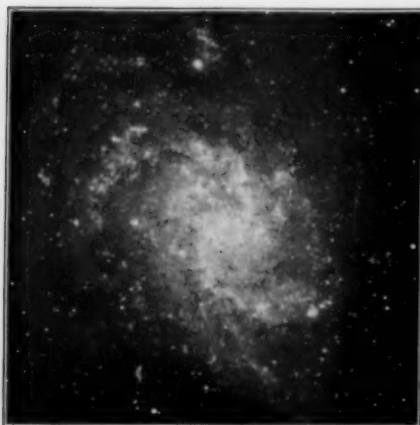
2. M 101 Urs. Maj. = N. G. C. 3770-3771.



3. M 74 Piscium = N. G. C. 372.



4. H IV 76 Cephei = N. G. C. 4594.



5. H 33 Trianguli = N. G. C. 352.



6. H I 53 Pegasi and her nebula.

PLATE I. SPIRAL NEBULAE.

nuclei and less and less dispersed matter, ending in those in which only a minute fraction of star substance was drawn out into spiral arms. As already noted, these arms or clusters of arms start at opposite sides of the nucleus and swing out in opposite directions with curvatures in the same sense. This singular feature is seen to be very persistent in the many thousands of spiral nebulae in the heavens and may well be regarded as highly significant of the process that gave rise to them.

It is worth while to note that though the degree of dispersion of a star into a spiral nebula may reach even to the essential deployment of the whole star, in certain cases, it is not violently catastrophic in any such degree as follows actual collision. It is partitive rather than extremely dispersive and dissociative. The disruption takes place by a



FIG. 7. A SPIRAL NEBULA WITH NEARLY CIRCULAR OUTLINE AND RELATIVELY FEW LARGE KNOTS. N. G. C. 278. Photo from Mt. Wilson Solar Observatory.

series of gas-bolts shot out in succession. The larger of these gas-bolts are supposed to retain mass enough, and hence self-gravity enough, to hold themselves together and so to constitute the nuclei to which the more scattered matter gathers to form the planets, planetoids and satellites into which the nebula later evolves. These bolts shot out by the successive pulsations of the eruptive action form into the knots that so distinctively characterize the spiral nebulae.

With extreme cases of approach within the Roche limit, and with very close approaches generally which give rise to highly deployed nebulae, we have nothing to do, except by way of illustration, in our search for the genesis of our planetary family. To fit this case, our sun is sup-

posed to have shot forth bolts to the amount of only $1/745$ of its mass to form the members of the planetary family. No doubt some additional matter was involved, but even when large allowance is made for such matter as may have been projected outward and yet returned to the sun, and for such other matter as was possibly shot so far out as to be drawn away by the passing star, and for some that may have been thrown beyond the control of either body, the fraction of the solar mass required to meet the demands of the case still remains very small. There is no reason to suppose that the sun's career as a star was radically affected. The approach was probably a rather distant one, in this particular case.

When the multitude of the heavenly host is considered, and the various directions and speeds of their motions are noted, the event to which the origin of the parent nebula of our planetary system is assigned must be regarded as one of the simplest and most inevitable that could well be named. There is little ground for doubt that actual collisions occasionally occur. There are six or eight chances that a star will pass through even the Roche limit of another star to one that it will collide with it. The chances that a star or massive dark body will pass near enough to an eruptive star to give rise to effective projections from its tidal cones, rise to very much higher order. Here again, the tenor of observed facts tallies with the nature of the theory offered, for the spiral nebulae are many times more numerous than any other class.

Let us follow a little more closely the assigned method of evolution of the little spiral nebula that is supposed to have grown into our planetary system.

When the passing star that incited the nebular deployment made its approach, its differential pull drew forth tidal "bulges" on the opposite sides of the sun. These were really cones rather than the broad bulges usually pictured, but superposed as they were upon a spheroidal surface they appeared as merely bulges, as commonly represented. The term cone, however, better represents their dynamic function. At the same time that the cones were drawn out on the line joining the sun and the star, a belt of inward pressure was brought into play at right angles to them. The joint effect of the protrusion of the cones and the compression at right angles to them was a concentration of the sun's eruptive tendencies into the cones. At the same time, the eruptive function was powerfully stimulated. As a result, the sun shot out gas-bolts from the quasi-volcanic cones whose mass was much greater and whose velocity was much higher than that of the eruptive prominences which are now shot forth at short intervals in a more sporadic way even in the absence of any such special outside stimulus or internal concentration. In the absence of a passing star these eruptions of course fall back to the sun. But if a bolt were shot far out toward the passing star, it

would be drawn forward by it. If only slightly drawn forward, it would return to the sun, but would carry back with it such transverse momentum as it had acquired. This would affect the rotation of the sun. The ejection on the opposite side of the sun would act in a similar way in accordance with well-known tidal principles. If the bolt were pulled forward sufficiently far it would fail to strike the sun on its return and would fall into an orbit about it. If the pull were effective enough, the projectile would not return at all to the sun but swing into an orbit about the passing star. If the respective pulls of the star and the sun against one another happened to be properly balanced, they would throw the projectile out of the control of both and it would go off into space and probably pass under the control of some other star.

Dr. Moulton traced out mathematically the courses of such projectiles in nearly half a hundred selected cases and found the process competent to give a wide range of results. In the first ten cases tried all of the contingencies just named were realized. The eccentricities of the orbits were often large, but the range of variation was such that when the many small bodies of the nebula were gathered into a planet the combined orbit would approach a subcircular form. The potency of the mechanism was found unexpectedly high; its efficiency as a partitive and distributive agency proved to be quite beyond anticipation.

It need not be urged that the solar eruptions under these conditions would be pulsatory, or that the gas-bolts would be subject to sub-fracturing and to the wide scattering of a part of their material. From such actions would arise "knots" of different orders and highly scattered "haze," the constituents which make up practically all spiral nebulae.

This, then, is the mechanism to which is referred the origin of our planetary system. It is of vital moment to note just how those critical features in our planetary system that seemed to offer so serious objections to the older hypotheses, are met under this interpretation. The gas-bolts shot out from the sun were, under the assigned mechanism, given transverse momentum by the attraction of the passing star. Thus the planets into which they were collected received their high endowments of moment of momentum, endowments that were proportionately of a much higher order than that of the sun. Some endowment was indeed received by the sun from the same source through the projectiles that fell back to it. The ancestral rotation of the sun is supposed to have been nearly opposite to its present rotation. The contribution of momentum from projectiles falling back first neutralized the sun's rotatory force and then reversed it, finally leaving it with the very slow rotation and slight obliquity it now has. As all the projected matter was shot either toward or from the passing star and was drawn forward in the direction of its movement, all the nebular orbits were in nearly

the same plane, and the nearly perfect disk of the final system was inevitable. Thus are explained the most radical features. The many other peculiarities of the system grew up as mechanical necessities in the subsequent processes of organization. Given a series of primary knots, the heads of the main gas-bolts of the more effective eruptions, attended by many sub-knots, fragments torn from these in the eruption, attended also by innumerable scattered particles ranging from molecules upwards, all thrown into elliptical orbits of varying eccentricities and slight deviations of plane, and the laws of mechanical aggregation did the rest. The primary knots were the predetermined nuclei of the planets. A multitude of lesser knots formed the nuclei of the planetoids. The secondary knots formed the nuclei of the satellites, while the highly scattered material of the haze was collected into the various nuclei and constituted the food for their growth.

Time forbids us to try to follow out the details. Though the scattered matter was originally molecular, it was neither gaseous nor meteoritic in any strict sense of these terms. It consisted of particles thrown into individual orbits of a common type moving in the same direction about the sun. The integers were thus from the outset of the dynamic nature of minute planets. To emphasize this radical feature they have been called planetesimals. The term embodies the soul of the hypothesis and suggests the dynamics that actuated the later evolution.

This evolution consisted of the natural and inevitable gathering of these planetesimals into the nebular knots serving as nuclei of growth forming ultimately planets, planetoids and satellites. The crossing of the initial orbits and the precessions and perturbations that inevitably arose from the interaction of various parts of the nebula, were the chief agencies in facilitating a gradual organization of the intertangled planetesimal system of elliptical orbits into the simpler and more harmonious sub-circular orbits of the present planets.

In the absence of time to delineate more fully this evolution, we may perhaps be pardoned an expression of the conviction that in the natural course of such evolution the many special features of the planetary system, not excepting its seemingly strange anomalies of rotation and revolution, find satisfactory explanation.²

Our special picture of the genesis of our planet, then, is that of an earth growing up about a nebulous "knot" through the rather slow accession of planetesimals, and taking on its mature form by gradual stages under general influences not radically different from those that presided over its later history, save in the gradual diminution of its rate of growth. Some of the salient features of this growth, some of the configurations that were acquired, and some of the dominant processes

² A fuller exposition of the hypothesis will appear in "The Origin of the Earth," a book about to issue from The University of Chicago Press.

upon which the planet entered, at maturity, will be the subject of our second lecture.

In a closing word, may I invite attention again to the essential simplicity of the assigned process of rejuvenation by which the sun gave birth to its present planetary family. It involves no postulate of general destruction and re-creation. There is no appeal indeed to any event that may properly be regarded as other than in the natural course of astronomic events. It is merely postulated that one of the simplest and most inevitable of astronomic events stimulated a partial deployment of the sun and gave birth to our modest little planet. The genesis of a planetary family was perhaps quite as much in the natural order of things in the heavens as was the initiation of a biological family in the course of terrestrial history.

IMMIGRATION AND THE WAR

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A CRISIS has been reached in our immigration policy. The war has, for the moment, very largely reduced the flow of aliens to our shores. For the first time in many decades we have breathing space. On the other hand, the effects of the war upon the peoples from which our future immigration will come are likely to be far-reaching. This fact will, after the war is over, bring us face to face with many new and difficult problems which need careful consideration at the present time. We must think clearly, decide wisely and act quickly. We need new immigration legislation. We need it at once.

Our present consideration naturally comes under three heads. First, the present status of immigration. Second, the probable future volume and character of immigration. Third, the necessary changes in our existing immigration laws.

The Present Status of Immigration.—From a total annual immigration of nearly a million and a half during the fiscal years 1913 and 1914, and an annual net increase in alien population (*i. e.*, deducting the numbers of those who returned to their own countries) of 800,000, the number of immigrant aliens fell to a little over 325,000 during the year ending June 30, 1915. Further, owing to the unusually large numbers who left this country, the actual increase in our population through immigration was only 50,000.¹

During the months July to December, inclusive, the number of arrivals was 169,291; of departures, 166,899, leaving a net increase of population of 2,392. The war has thus brought us, suddenly and unexpectedly, face to face with a great experiment in restriction—restriction of a far more drastic sort than has ever been suggested by any but a few of our most radical exclusionists. Furthermore, the war has brought, temporarily, an interesting change in the racial character of our alien arrivals. The majority of those coming in recent months has been from northern and western Europe, whereas, under ordinary conditions, nearly three-quarters of our immigrants are southern and eastern Europeans. The British Isles, Holland, Denmark, the Scandinavian countries, from all of which there has been a fairly regular steamship service, have kept on sending us about their usual quota. Of those aliens who have returned home for military duty, the large ma-

¹ For the sake of simplicity, these statistics are given in round numbers.

jority came originally from southern and eastern Europe. Immigration restrictionists have observed with satisfaction that there has been less unemployment than usual during this winter, even in our large eastern cities, and realize, what they have always maintained, that reducing the inflow of unskilled labor must inevitably simplify and lighten all our burdens of public and private charity. They observe, also, that there has been no widespread, serious or disturbing lack of labor in our great industries or public undertakings. The predictions of those who have persistently maintained that even a very moderate restriction of immigration would immediately lead to a labor shortage and greatly curtail our industries have been shown to be in error. It is true that there has been somewhat of a deficiency in the supply of domestic servants, especially in New York City. This is partly due to the demand of the factories for more operatives. And in any case, the situation is not without its advantages, if it results, as it undoubtedly must, in more efficient and less wasteful housekeeping.

An important eastern newspaper, which has always strongly opposed the further restriction of immigration, recently lamented the fact that the present small alien inflow would result in somewhat higher wages for our laboring classes. This puts the case very squarely before us. Unrestricted immigration; lower wages; cheap labor; un-American standards of living, on the one hand. A reasonable selection and restriction of immigration; better wages; more intelligent labor; American standards of living, on the other.

The Probable Future Volume of Our Immigration.—Is immigration likely to be greater after the war than before it? Or are we to witness a general and more or less permanent decrease? Our economists are already considering this question, and Commissioner of Immigration F. C. Howe, of New York, has discussed it in several magazine articles. With most of Commissioner Howe's conclusions we find ourselves in general agreement. The demoralization of industry; the breaking-up of homes; the roving restlessness of millions of men who will never be able to "settle down" again at home; the greatly increased burdens of taxation; the desire to fly from the horrors of future wars; the political, religious and social readjustments with the almost inevitable oppression and dissatisfaction of multitudes of people; the widespread destitution, misery and hopelessness; the return to the United States of aliens who went home to fight and who will bring back with them many of their countrymen who have never been here; the desire of the foreign-born already in the United States to bring to America relatives and friends who are still left abroad—these and other causes will operate to bring us an increase in immigration which seems likely to surpass anything that we have ever known. It is easy to see what use the steamship agents

will make of the conditions following the war, in order to stimulate emigration from abroad. "Fly from the horrors of war; escape your taxes; go to a country where there are no wars; where there is no standing army; where wages are high and work is plenty; go to America." A considerable proportion of our immigration even in normal times is thus artificially stimulated. What will happen after the war it is easy to guess. Already, plans are being made by foreign companies for the establishment of new steamship lines, to bring emigrants from Europe and Asia to the United States.

All this is not mere idle speculation. Our statistics show that recent wars have in no case been followed by any permanent decrease in emigration from the countries involved. On the contrary, as Professor J. W. Jenks has pointed out, these wars have usually resulted in a large and almost immediate increase. After the Franco-Prussian war, immigration to this country from Germany and France increased, and attained its maximum not many years after the war. Greek immigration increased steadily after the last Turco-Grecian war. The more recent Balkan war was followed by increased immigration from the Balkan states. The numbers from Serbia, Bulgaria, Montenegro and Greece in the year after that war were nearly double those of the year preceding the war. Those who may maintain that immigration will decrease permanently after the present war is over have no statistics on which to base their claim.

On the other hand, of course, there will be tendencies which may operate to cut down emigration from certain European countries. An enormous amount of constructive work will have to be done, in the rebuilding of roads, railways, bridges, factories and dwellings, and in the general rehabilitation of what the war will have damaged or destroyed. Immense numbers of skilled and also of unskilled workmen will be needed for these enterprises. Owing to the thinning of the ranks of the most efficient laborers, by death or by injury, during the war, wages may perhaps rise, but whether the impoverished nations of Europe will be able to compete with our American wages, and thus keep their people at home, yet remains to be seen. Again, it is not unlikely that some of the European governments will take steps to discourage, to check, perhaps even for a time to prohibit emigration. The work of reconstruction after the war will go on most actively and most effectively in the countries of northern and western Europe, where the state and industry are well organized, and where the plans for reorganization will be carefully prepared. It is in these countries that there will inevitably be the most immediate and best paid opportunities for the largest number of laborers. And it is, therefore, from these same countries, from which we have in the past received our all-around "best" immigrants, that we

are likely to see the greatest falling off in immigration. On the other hand, in the countries of southern and eastern Europe and of western Asia, immigration from which has been on the whole more of a problem, because of the differences in race, political institutions, education and social habits, there will not be the same organized reconstructive work. From these countries, therefore, so largely in the more primitive condition of agriculture, the forces tending to promote emigration will be operative to a much greater degree than ever before. Thus the great preponderance of southern and eastern Europeans, already the most striking feature in our recent immigration, is likely to be still further increased after the war is over. To put it briefly, the centripetal tendency, to keep people in Europe, will be greater among the nations of northern and western Europe; the centrifugal tendency, to drive people out, will be greater in southern and eastern Europe, and in western Asia. Balancing the reasons for a possible decrease in our immigration after the war against those which will bring about an increase, the weight of probability is strongly on the side of a marked increase. This increase will doubtless for some years be largely one of women and children, whose care will throw a very heavy burden upon all our charitable agencies.

The Probable Future Mental and Physical Character of Our Immigration.—No one who has at heart the future of the American race can fail to view with concern the probable effects of the war upon the physical, mental and moral condition of our immigrants. The introduction of pestilential war diseases, such as cholera, typhus, typhoid fever and the like, is not greatly to be feared, although some of our medical men are already viewing this problem with much concern. On the other hand, the more subtle and much less easily detected venereal diseases, which are always rampant in great armies in war time, and the mental breakdowns, of which there are so many thousands of cases among the soldiers at the front, present another aspect of the health problem which is far more serious.¹ Great numbers of soldiers, although not actually afflicted with any specific disease, will eventually come to the United States, maimed, crippled, wounded, enfeebled by illness or exposure, or mentally unstable. The fittest, mentally and physically; those who in the past have had the initiative and the courage to emigrate, will be dead, at the prime of life, or will be needed at home to carry on the work of rebuilding and reorganization. These are the men whom Europe will do its utmost to keep at home. The least fit are likely to emigrate. Many of those who, because of mental or physical disability, will find themselves least able to earn a living abroad, will be the very ones most

¹ It is very significant that the final report (March, 1916) of Lord Sydenham's Royal Commission on Social Diseases dwells particularly upon the inevitable effect of the war in greatly increasing the seriousness of the situation.

likely to be "assisted" by relatives and friends in this country to "come to America." Against the emigration of such persons the European governments will not set up any barriers. There are good grounds, therefore, for expecting, with reasonable certainty, that our immigration in the next few decades after the war will be of a lower physical and mental standard than it has been in the past.

The moral effects of the war are by no means to be disregarded. As Commissioner Howe has clearly pointed out, a widespread demoralization will prevail among the peoples now at war, resulting from life in the army; the breaking off of family ties and responsibilities; the restlessness and difficulty of settling down again after the fighting is over; the craving for freedom and liberty as soon as the military discipline is relaxed. Our future immigration is sure to contain a large proportion of these disturbed, restless, irresponsible men; less amenable to law and order; less disposed to conform to our conditions of life; less easily assimilable, than has been the case in the past. The interruption of the education of multitudes of young men who have been called on for military service, and who will never take up again their scholastic or vocational training, is a serious phase of our general problem. This group will go forth into the world insufficiently and unsatisfactorily prepared for the business of life. For years to come, our immigration will include large numbers of youths and of men whose standards of education will be lower than would have been the case had there been no war.

And what of the more distant future? What of the effects upon the unborn generations? This question is obviously a difficult one. Opinions vary greatly in regard to it. As a rather extreme representative of one side, we may turn to Dr. David Starr Jordan's latest book, whose title clearly indicates the message which its author seeks to bring, "War and the Breed: the Relation of War to the Downfall of Nations" (1915). War, as Dr. Jordan strikingly puts it, "impoverishes the breed." The strongest and best men are the ones who are killed or injured, and who leave few or no children. The weaklings live, marry and continue the race. The result is an inevitable impoverishment of the stock. Dr. Jordan notes the reduction in the required height of French soldiers as the result of the Napoleonic wars and the killing off and wounding of the taller men. The French and German babies of 1870-71 who came to be mustered as soldiers twenty years later, were found to be an inferior lot of men. And, more recently, as noted by Dr. Jordan in *Science* (New York), a similar condition has occurred in Japan. The Japanese children born at the time of the war between China and Japan, twenty years ago, became conscripts in 1915. According to the *Asahi* of Tokyo, as translated in the *Japan Chronicle*, the number of conscripts in Tokyo decreased over 16 per cent. For Japan

as a whole there was an increase of conscripts in 1915, but the rate of increase was only 30 to 50 per cent. of the normal. Furthermore, a lowering in the quality of the new soldiers is distinctly observable. The *Asahi* says that "most of those who underwent conscript examinations this year were born during the war and therefore are sons of those too old or too weak to go to the front, and so it is no surprising thing if the conscripts of 1915 are of exceptionally delicate constitution." This "impoverishment of the breed," in Dr. Jordan's opinion, is an inevitable result of war. The longer the conflict continues, the more serious will be the effects upon future generations. The weakling fathers—too young, too old, or too feeble to fight—and the improperly nourished, overworked and harassed mothers of Europe, are handing on to their children who are now being born an inheritance of physical and mental unfitness which will mark not only this generation but future generations, through the long vista of the time to come. An increase in the number of defective children, now and hereafter, is a condition which Europe must face, and which, because it will affect the character of our immigrants, vitally concerns the United States. Dr. Aleš Hrdlička, of the Smithsonian Institution, one of our leading anthropologists, contributes to Dr. Jordan's book an opinion as to the probable effects of heavy artillery firing on the nervous systems of soldiers in the war. He believes that subjection to the constant roar of the firing will "result in a more or less defective mental or nervous state in the progeny of such individuals."

Dr. Jordan's view may be thought rather extreme. The problem is a highly complex one. There are not lacking those who take a different position. It is pointed out that wars have been so constant, not only in Europe, but over most of the world, that if wars do result in racial deterioration, national degeneracy should have followed them. Again, it is urged that by no means all of the physically and mentally fit who go to war are killed, or are so impaired in body or mind as to be undesirable fathers for future generations of offspring. The number and the quality of the men who will survive the war is at present an unknown and indeterminable element in the problem. Professor Roswell H. Johnson, of the University of Pittsburgh,¹ has recently warned us¹ against sweeping and unqualified statements that war is either good or bad in its effects on the human race. Some wars are mainly good; others mainly bad. A conscripted army is likely to be physically, and probably also in other respects, superior to the bulk of the population. The conditions of poverty, improper sanitation and inadequate medical treatment in the homes tend toward a deterioration of the race. Many factors must thus be taken into account. In summing up his argument, Professor Johnson says:

¹ *Journal of Heredity*, December, 1915.

In the present war it would seem that the high quality of both sides compared with the rest of the world is so predominant a dysgenic factor that, together with the other dysgenic features, the eugenic results are overbalanced. The human species therefore, on account of this, is at present declining in inherent quality faster than in any previous length of time.

In connection with this particular subject, it is highly significant that Germany, which is universally recognized as preeminently the military power of the world, and whose scientific study of military problems is so thoroughly organized, should already be giving serious attention to the racial effects of the war. On October 26-28, 1915, there was held in Berlin, a *Tagung für die Erhaltung und Mehrung der deutschen Volkskraft*—surely a highly significant designation. Over one thousand delegates attended, and the proceedings were marked by an extraordinary unanimity of sentiment. It was recognized that "war kills the best, the bravest, the healthiest, eradicating once for all the finest strains of the race." There was serious discussion with a view to bringing about an increased multiplication of the fit by various means, chiefly the assistance of large families of healthy stock.

From the foregoing considerations it appears that the effect of the Great War upon the United States, will, unless all signs fail, be profound and far-reaching. For it will affect the mental, physical and even moral characteristics of millions of our future immigrants and of their descendants.

The Idealist and Immigration Restriction.—There is still in our midst a group of idealists who shudder at the mere thought of a further regulation of immigration. They hold fast to the vision of the universal brotherhood of man. They call "narrow," "ungenerous," "selfish," "un-American," any one who suggests further immigration legislation. They point out what an enormous debt our country owes to its foreign-born citizens. They never tire of reminding us of the remarkable achievements of foreign-born children in our public schools. They have absolute confidence in the strength of our institutions to assimilate all people, of every land, who may choose to come here. They believe that this is the world's great "melting pot," where race hatred and race differences are to be forever done away with. They produce such endless and impressive statistics to prove that our recent immigrants are far ahead of the native-born in all that pertains to good citizenship that we sometimes cannot help wondering how our ancestors, of Anglo-Saxon stock, who originally settled the United States, ever had the genius and the wisdom and the courage to fight the Revolutionary War, or to develop our American democratic government. They believe in keeping the United States forever the "asylum and the refuge for the down-trodden and oppressed of all nations." Wonderful ideals these are, and tremendously inspiring, when eloquently presented, is the

thought of the "haven of refuge." Yet those who hold these views, sincere though they are, are nevertheless inconsistent. Not one of them really believes in a "haven" open, unrestrictedly, to all comers. Not one really believes that we ought to admit, unreservedly, the insane, the idiot, the criminal, the prostitute, those who have "loathsome or dangerous contagious disease." There are probably none of them who want our doors wide open for all time for the incoming of millions upon millions of Chinese, Japanese and Hindus. They may think themselves perfectly sincere when they use the haven argument, but they are obviously not so. They really do not want their "asylum," of which they say so much, to become an insane asylum, nor their "refuge" to become an almshouse or a penitentiary.

Standing close behind these idealists—whom the late Gen. Francis A. Walker well termed "optimists beyond all bounds of reason"—and using the same eloquent and catchy appeals, come the manufacturer, the land owner, the contractor, the railroad and the steamship man—all profiting directly through the influx of unlimited "cheap labor"; all demanding more "hands," and most of them indifferent as to the conditions of the bodies and of the minds which of necessity go with these "hands." Our large employers of labor naturally enough use the "brotherhood of man" and the "haven of refuge" appeal. It blinds people to their real motive. Thus many of our idealists have been misled into cooperating with these "big money" interests, not realizing that the true motive which controls these is purely selfish. Another group which is strongly opposed to immigration restriction is made up of the leaders of our foreign-born colonies, mostly contractors, steamship agents, small bankers, newspaper men, and the like, all of whom feed on our recent immigrants and want the supply to continue as large as possible. And politicians whose positions depend upon the votes of foreign-born citizens constitute another small but very noisy group, also ranged behind the banners inscribed "Haven of Refuge" and "Asylum for the Oppressed." Professor E. A. Ross, of the University of Wisconsin, has clearly brought out one fact in regard to the idealists which is not generally appreciated and yet has great significance.

The investor, landowner, and contractor can well afford to preach worldwide brotherhood. The professional man sitting serene above the arena of struggle can nobly rebuke narrowness and race hatred. Throughout our comfortable classes one finds high-sounding humanitarianism and facile lips of sympathy for immigrants coexistent with heartless indifference to what depressive immigration is doing and will do to American wage earners and their children. If the stream of immigration included capitalists with funds, merchants ready to invade all lines of business, lawyers, doctors, engineers, and professors qualified to compete immediately with our professional men, even judges and officials able to lure votes away from their own candidates for office, the pressure would be felt all along the line and there might be something heroic in these groups

standing for the equal right of all races to American opportunities. But since actually the brunt is borne by labor, it is easy for the shielded to indulge in generous views on the subject of immigration.

Necessary Changes in Our Immigration Laws.—There is one thing about our immigration legislation which it is essential to keep in mind. The whole subject is a very difficult one. To understand it one must know the history of immigration and of our immigration laws from the beginning; the regulations which at different times have governed the enforcement of these laws; the interpretations which have been put upon them by the courts; and the actual workings of the laws as compared with the way in which they were intended to work. For the layman to have knowledge of these facts is clearly rarely possible. And laymen who, without sufficient knowledge of the subject, write or speak on immigration legislation, simply add to the confusion, bring themselves into ridicule, and delay the enactment of proper laws. In this matter, as in so many others, the only way is to accept the conclusions of the experts. Our present immigration laws aim to exclude some twenty-one classes of mentally, physically, morally and economically undesirable aliens. On paper, the list of the excluded classes is long and formidable, and seems amply sufficient. But careful and unprejudiced students of immigration, both within the immigration service and outside of it, agree that we have not been keeping out the unfit sufficiently even to preserve the mental and physical *status quo* of our population, to say nothing of promoting any improvement. These laws grew up slowly, as the result of experience extending over many years. They have served as the basis for the immigration legislation of Great Britain and of Canada. They were not the result of any "know-nothing" agitation, of the sudden demand of a political party, or of the whim of a moment. As recently as 1875 we excluded only criminals and prostitutes. Slowly, deliberately, carefully, this legislation was planned and enacted. Nevertheless, the experience of years has brought the defects to light. Competent government immigration officials have pointed them out. Disinterested citizens, and economists, and medical men and social workers, have studied these laws, and have shown us where they fail to accomplish their purpose. The last few years have witnessed a very remarkable spirit of cooperation among our experts on immigration matters in the effort to frame new legislation which shall really be adequate to meet the conditions which experience has shown to exist. There is a bill now before the House of Representatives (H. R. 10384, Union Calendar No. 36, Report No. 95) which, all things considered, is the most comprehensive immigration bill ever introduced into Congress. It is the result of years of careful study of our present law and of its workings. Its provisions, as the commissioner-general of immigration says in his last annual report (June 30, 1915), "contain

the result of experience and investigation—of the experience of administrative officers, extending over nearly a quarter of a century, in the enforcement of various statutes regulating immigration, and of the investigations conducted variously but in particular by the Immigration Commission, created under the act of 1907, the report of which, comprising 42 volumes, was submitted to Congress in December, 1910." The provisions of this bill "have been drawn with great care and thoughtfulness, . . . by them the law is made certain in its definitions and clear in its term throughout—improvements badly needed in the existing statute." The bill aims to protect the United States against the incoming of mentally and physically, and of otherwise unfit and undesirable aliens. It also embodies several provisions which would ensure more humane treatment to the aliens themselves, and would, to a large extent, do away with the hardships involved in the deportation of aliens who are excluded at our ports, by preventing their original embarkation. And in response to the ever increasing demand—greatly strengthened by the probable effects of the war—for the further restriction of economically undesirable immigration, the bill also proposes certain amendments designed to keep out some of this group.

The bill is largely a codification of our existing immigration laws, but embodies several important new provisions. It is clearly out of the question to discuss this bill, which covers 62 pages of print, in detail in the present article. It is our purpose merely to call attention to a few of the more important changes which its enactment would make in our present laws, but with special reference to the exclusion of the mentally and physically unfit. In regard to the better detection, exclusion and deportation of this group there is no essential difference of opinion among those who have the future of our race at heart. The unanimity of feeling in this matter is encouraging, but, in view of our past experience with mentally and physically defective aliens who have been admitted to this country, it is not surprising.

To the excluded classes the bill adds *persons of constitutional psychopathic inferiority* and *persons with chronic alcoholism*, both of which designations have a definite meaning to alienists, and to the surgeons of the United States Public Health Service. That many persons not properly to be certified as insane but who would, in many cases, become insane soon after arrival, could be kept out under the former provision, has long been the opinion of the physicians, the alienists and the immigration officials who have made a special study of this subject, and who have for years strongly urged the inclusion of this new provision in our immigration law. Chronic alcoholics, who are surely undesirable members of our community, are often discovered by our examining surgeons, but as the law does not now state specifically that

they shall be excluded they must in most cases be allowed to land. The new bill excludes *vagrants*, and *persons afflicted with tuberculosis in any form*. It also aims to prevent the embarkation of aliens afflicted with idiocy, insanity, imbecility, feeble-mindedness, epilepsy, constitutional psychopathic inferiority, chronic alcoholism, tuberculosis in any form, or a loathsome or dangerous contagious disease, by imposing upon steamship companies who bring such aliens a fine of \$200 plus the amount paid by the excluded alien from his initial point of departure provided the secretary of labor is satisfied that the defects could have been detected by a competent medical examination before embarkation. This is an excellent and humane provision, and would go far toward making these companies more careful in the sale of passage tickets, and would save many unfortunate aliens the disappointment and hardship of being deported after arrival at our ports. The present fine is \$100, has been shown to be too small to be really effective, and does not cover as many cases as are above enumerated. A new fine of \$25, plus the alien's transportation expenses, is established in cases of certain other less serious mental defects, and of physical defects which may affect an alien's ability to earn his living.

The new bill provides for a very much more thorough medical examination of arriving aliens, especially with reference to the detection of mental diseases; gives the medical inspectors the exclusive services of interpreters, and suitable facilities for the detention and examination of the aliens. This amendment has been strongly urged by the united action of the most important scientific bodies in the United States which deal with the prevention and treatment of mental disease, by state medical associations and by individual physicians all over the country. That our medical inspection has been hopelessly inadequate has long been known to the experts. We have not had enough medical inspectors, and those on duty have not had adequate facilities for their work. Thus it has come about that, in spite of our law prohibiting the admission of insane and mentally defective aliens, our institutions have been filling up with just these people. As Dr. T. W. Salmon, of the National Committee for Mental Hygiene, has well said:

There is no reason for the acceptance of a single insane or mentally undesirable alien except inability to determine his condition.

It is a very significant fact that, with the decrease in immigration since the war, particularly at New York, a more rigid medical inspection has become possible. This "intensive examination" has resulted in a marked increase in the numbers of aliens certified as having physical or mental defects. "Certainly," says the commissioner-general, "there could be no better or more convincing argument . . . for increasing the medical force sufficiently to insure that no alien shall be admitted to the

country until he has been subjected to a medical inspection really calculated to disclose his mental or physical deficiencies." With this statement all public-spirited citizens will surely agree.

The new bill extends from 3 to 5 years the period during which aliens may be deported who at the time of entry belonged to one or more of the excluded classes; who have become public charges from causes existing prior to landing; and of some other groups. This extension of the deportation period has been urged, year in and year out, by heads of institutions who have had to do with dependent, defective and delinquent aliens, by organized charitable societies, and, perhaps most strongly, by the former commissioner of immigration at the port of New York, Hon. Wm. Williams, whose thorough, sane and illuminating study of the whole immigration problem has contributed greatly to our understanding of the subject. It is the conviction of all the unprejudiced experts who have studied this problem that a five-year deportation period would relieve our penal and charitable institutions of an enormous financial burden, reaching into the millions of dollars, and would rid our communities of large numbers of defectives who otherwise would remain here, many of them a burden upon state or city, and many of them starting long lines of defective and delinquent children.

The new bill strengthens the provisions of existing law regarding the "White Slave" traffic; makes the inspection of steerage quarters more thorough; compels steamship companies, when deporting aliens, to give such aliens as good quarters as those for which they paid on the voyage to this country; makes possible the expulsion from the country of alien anarchists and criminals, even when they have become such after entry; and in many other ways provides for the welfare of the alien as well as for the welfare of the United States.

All these new provisions regarding the more effective exclusion and the deportation of mentally and physically unfit aliens have been carefully drawn, as above stated, after consultation with experts who have seriously studied these particular aspects of our immigration problem. They were all suggested and strongly urged upon Congress years before the war broke out. Their enactment into law should have been effected long ago, under the usual conditions of normal immigration. But every argument in favor of this legislation has gained weight, incalculably, in view of the probable effects of the war upon the character of our future immigrants. As the commissioner-general says in his last annual report, the adoption of these amendments now "becomes an imperative necessity." It is for the best interests of our future race; it is for the best interests, in the long run, of humanity at large, to prevent, as far as may be possible, the coming to this country of the mental and physical derelicts of the war. It is unfair and ungenerous

to future generations of Americans to saddle upon them the tremendous burden of supporting not only the present generation of these people, but the long lines of their descendants. It is not doing our share in the promotion of race betterment if we, who have the matter in our own hands to-day, do not act at once, before it is too late.

The demand from the country at large for a further restriction of immigration which is "economically undesirable" has resulted in the inclusion, in the pending bill, of certain provisions which aim more or less directly at restriction, whereas the amendments above considered, relating to mentally and physically unfit aliens, are rather matters of the public health and safety than of a large regulation of immigration. It is clearly the temper of Congress as shown during the past few years, to combine all immigration legislation into one general bill. Hence we must consider briefly the provisions which have an economic, as well as those which have medical bearing.

The new bill excludes Hindus, whose immigration has only recently begun, but whose coming in inevitably larger and larger numbers will, if unchecked, lead us into many serious racial and economic difficulties. It increases the head tax from \$4 to \$8, but exempts children under 16 who accompany their father or mother. Under the present law, every alien, even an infant in arms, is required to pay a tax of \$4. In practice, however, the tax is paid by the steamship company, and is not a provision oppressive to the arriving alien.

The new bill provides for a reading test, in a very mild form, by excluding "all aliens over 16 years of age, physically capable of reading, who can not read the English language, or some other language or dialect, including Hebrew or Yiddish." Sweeping exceptions are made in the case of fathers and grandfathers over 55; wives, mothers, grandmothers, unmarried and widowed daughters; and of all aliens who are fleeing from religious persecution abroad. This is not the place to present any argument in favor of the reading test. It was recommended by 8 out of 9 members of the U. S. Immigration Commission "as the most feasible single method of restricting undesirable immigration." It has been endorsed, over and over again, by state legislatures; boards of charity; philanthropic organizations of all kinds; labor bodies; chambers of commerce; by our leading authorities on immigration and by citizens in all walks of life. In the past twenty years a reading test, often in a more severe form than the one at present proposed, has passed one House of Congress or the other more than twenty times. It has been truly said:

If ever the citizenship of the United States has given endorsement to any measure of legislation, it certainly has done so to the principles embodied in this bill.

Of course, to object to the reading test on the ground that it "will not exclude the educated rascal" is a sign either of gross ignorance or of a wilful attempt to mislead. The reading test is not to replace any existing provision of the present law. It is to be added to our present provisions. Criminals are already mentioned among the excluded classes, and we keep them out when we can, and as well as we can, although everybody familiar with the law, and with the difficulties of its enforcement, knows perfectly well that we really have no effective means of keeping out this group. No one maintains that the reading test is an ideal, or a perfect "solution" of our problem. As the editor of the *Review of Reviews* recently wrote:

The application of new tests could be made now with less practical inconvenience than at a later time. That of ability to read is far from being a logically perfect one; but it was recommended by the Immigration Commission, several years ago, after a vast and impartial study of the whole problem. It is not likely that this test would operate to shut out very many desirable immigrants. It would, however, affect appreciably that great tide of labor that moves back and forth in the steerage, retaining its citizenship in the countries of eastern and southern Europe. The literacy test could be so modified and applied in a reasonable spirit as not to exclude many families whose addition to our citizenship is to be encouraged.

And Dr. Edward T. Devine, than whom we have no higher authority on all matters of public and private philanthropy, has, in endorsing the reading test, expressed similar views.

A bill containing a similar provision was vetoed by President Cleveland March 2, 1897, partly because of an objectionable clause which would have led to friction with Canada; was promptly passed over his veto by the House, and would have been passed over the veto by the Senate if it had not been crowded out by a tremendous pressure of business just in the very last hours of that Congress. The pending reading test is much more liberal than that of twenty years ago. There was not the same reason for it then as there is now. *And President Cleveland said, after the expiration of his term, that his veto of that immigration bill was one of the great regrets of his public life.* In February, 1913, a general immigration bill embodying a reading test passed both Houses of Congress by an overwhelming vote, and was vetoed by President Taft. Instead of writing his veto message himself, President Taft sent to Congress a memorandum written by his Secretary of Commerce and Labor, Hon. Charles Nagel, of St. Louis, who had always been strongly opposed to any really effective regulation of immigration. This bill passed the Senate over the veto by a vote of 4 to 1, and was lost in the House by only a few votes less than the necessary two thirds.

During the last Congress (sixty-third) a very similar bill passed the House by a vote of 2 to 1; the Senate by a vote of 7 or 8 to 1; and only

failed by a few votes of passage over President Wilson's veto. The latter was based partly upon a clause in the bill which seemed to the President to take away the right of asylum in this country for political refugees. This matter has been remedied in the present bill.

Thus the pending bill comes up before Congress once more, embodying provisions for the preservation of our public health by more effective exclusion of mentally and physically undesirable aliens; providing for more humane and fairer treatment of the aliens themselves; and excluding certain additional groups which, in the opinion of our immigration experts, are economically or racially unfit. It is natural that so complex a bill, codifying all our existing immigration laws, and making changes in them, should meet with opposition. Some of this opposition is honest and sincere. Much of it is based on misconceptions of what the present law is and of the ways in which the new bill would modify it. Much of it is the result of agitation by "interested" persons who do not hesitate to mislead the foreign-born members of our communities by wilful misstatements of facts, and deliberate falsehoods regarding the actual wording and purpose of the bill. When no less eminent a citizen than Cardinal Gibbons was misled into thinking that the immigration bill which passed the last Congress required ability to read *English*, it is not surprising that the great masses of our recent immigrants are even more mistaken. Much of the opposition, now as always, comes from the railroad and steamship companies, and from the large employers of labor. Some of it is coming from the Japanese and the Chinese.

In the midst of all this tangle, it is the business of those of us who know the facts, and who understand the purpose and meaning of the new bill, to keep our minds clear and sane; to urge, insistently, that more attention ought to be paid to the needs of the people of the country as a whole and much less to the meetings, and speeches, and noisy "resolutions" of this or that group; to point out that the mental and physical welfare of the future American race should first of all be safeguarded, and that the demands of any local, or temporary, or selfish, or narrow interest are not for an instant to be put ahead of this, the most important of all our national responsibilities.

BUILDING AND LOAN ASSOCIATIONS THE SOLUTION OF
THE RURAL CREDIT PROBLEM

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THE enjoyment of his personal credit has become a matter of larger concern to the thrifty bread winner during recent years than was formerly true. The limiting of liability for collective indebtedness and the abolishment of prison sentences for debt, which took place simultaneously in civilized countries a half century ago, did much to relieve the odium and danger which prior to this time had attended using one's credit and made borrowing—especially for productive purposes—not only permissible, but actually commendable.

The opening of this newly approved field of opportunity was at once taken advantage of by many new credit-handling organizations. Banks increased in numbers wonderfully and, in addition to banks, trust companies, savings banks, building and loan associations, investment companies and many other credit agencies of lesser note came into existence for the handling of certain special supplies of or demands for this great resource. Credit is, indeed, in all its aspects essentially of the same nature—the transfer of something of a valuable character to another without an immediate equivalent in return—and it has as many varieties as there are credit agencies, or, literally, as there are uses or supplies. Thus there is bank credit, building and loan credit, merchants' credit, and, more technically, short or long credit, secured and unsecured credit and many others reflecting the effects of multitudes of practical influences.

The farmer's need for credit is of a highly specialized sort. The canvass of the credit needs of the farmer made by the Department of Agriculture in 1912-13 shows that it is customarily a period of from four months to four years which measures the length of the loan which farmers desire to make. The credit loans made by farmers for the shorter period is in the nature of advances upon crops for the growing of which the farmer is naturally short of means at seed time, but is opulent at time of marketing, for carrying cattle through feeding time and, in short, for defraying current expenses. The longer period of credit loans is for buying land, building silos or for making other permanent improvements. It will be seen at once that the farmer's use of credit is for investment purposes and that his patronage of customary banking agencies helps but little the store of liquid assets which are indispensable to the successfulness of the ordinary commercial banks.

The ordinary commercial banks are indeed limited by many handicaps in their dealings with farmers. In addition to purveying a variety of credit, which at its best is absolutely useless to farmers, commercial banks have an expensiveness of management which increases materially the cost of borrowing to the farmer. The up-to-date consumer and producer of commodities everywhere believes firmly that a cause of the current high prices of commodities may be found in the existence of too much interference, too much friction, too many hindrances (as a result of our middleman system) in the passage of products from their place of origin to their place of consumption. May not a similar explanation account for the high charges which bankers make for the transfer of credit from the hands of depositors to the hand of borrowers? Expensive legal regulations, for example, restrict the banker in all directions. He is legislated upon with regard to inspection, to his reserves, to his ownership liabilities, his interest charges, his mortgage foreclosures, limitations of loans to borrowers, creditability of farm lands to one half value, form of bank issues, character of securities, etc. An examination of these typical regulations will show that most of them are framed in the interests of the depositors and have for their purpose the worthy object of insuring a bank's business safety. But are such safeguards necessary for credit agencies which deal only with farmers, and should the countryman pay the increased price for his loans caused by the regulations which are intended as safeguards against the more speculative business of the city?

So small a point even as that of variation in business habits on the part of farmers and bankers tends constantly toward the estrangement of these two classes each from the other. The farmer is proverbially *lax* in keeping appointments with a bank, but the bank proverbially is adjusted to methods of punctuality. Most farmers also wish the cash itself when borrowings are made from banks, instead of merely credit; on the other hand, bankers wish to loan credit and are loath indeed to allow cash to be taken from their possession. Little frictions of this sort, however, are not, in fact, irremediable, but the serious one of applying an agency adjusted to the demands of one occupation to performing a service for another and very different occupation does not seem easily capable of reconciliation.

The penitential self-searching which our nation gave itself a few years ago in carrying out the far-famed conservation movement resulted in a few things which promise to be more lasting than the discovery of agricultural credit. It is true that farm credit had not been unknown among our many economic resources prior to this time, but it required the stress of a national hunt seeking our most remote and minutest assets for conservation purposes to bring out this great utility and reveal its actual proportions and real importance. It is with the con-

ervation movement then—conservation of our human as well as our natural resources—with its problems of reforestation, of slum recovery, of desert reclamation and white slavery that the question of rural credit comes up.

A contributory reason for the appearance of this question among us, furthermore, is found in the enormous growth in value attained by farm property in recent years. The census of 1910 shows that during the preceding decade farm land had increased in value more than 100 per cent., and that the annual agricultural output had grown from about four billions in 1899 to nine billions in 1910. It has now grown to many more billions than this, with corresponding increases in the value of land. The existence of so much negotiable wealth in any occupation must necessarily add immensely to the credit possibilities within that occupation over what had previously prevailed.

The handling of the credit which arises from this stupendous amount of wealth has rested mainly in the past with the ordinary commercial banks of the country. The growth in numbers and profitableness of these institutions—national, state and private—within the last decade and a half is looked upon everywhere as phenomenal and little doubt can be felt by any one that much of the prosperity which this banking pursuit has enjoyed is derived from the increasing prosperity of farmers. The commercial banks indeed have been wide awake to the possibilities of this new field of credit resource—especially from the standpoint of its furnishing a new source of credit supply or deposits. In addition to the usual advertising, for example, which banks of all sorts put out to secure customers, bankers' organizations, both state and national, have in recent years appointed active committees upon agriculture to look after this interest in connection with their occupation, one or two agricultural banking periodicals have come into existence, local bankers have been among the chief promoters of the county farm agent undertaking in our various counties and banks everywhere vie with the railroads in the promotion of agriculture in the different neighborhoods through financing dairy-yield rivalries or alfalfa- and corn-growing contests.

The outcome of greatest note from the abnormal credit conditions described above has been the enlistment of the national government in the cause of improved rural credit. The Washington authorities have actively sympathized with the improvement of farm credit facilities for at least two reasons. First, because it was thought that better credit to the farmers would better agricultural production and lower the cost of living; and, second, because an improved supply of long-time farm credit might stop the spread of tenancy which is now so menacing, through allowing more farmers capital wherewith to buy farms. A gathering of the House of Governors considered the proper steps to be taken upon this matter in 1912, and two great commissions were sent abroad

by the combined state and national governments a year later to study the problem in Europe. The report to Congress of one of these commissions embodied a bill which provided for land-mortgage banks chartered by the federal government which should be similar in character to those of European countries. This bill was actively considered by congressional committees during the entire year following a promise from the administration in connection with the enactment of the federal reserve law, that rural credit legislation should be immediately taken up for adoption under a separate bill. The president's annual message also strongly urged the adoption of rural credit relief. In spite of this promise and this message, the rural credit bill was finally shelved so far as the first Wilson congress was concerned, by a congressional caucus late in the session. The Congress which ended last March appointed finally a commission, which should hold recess "hearings" and bring in a satisfactory rural credit bill at the commencement of the present session.

The improved rural-credit plan toward which the government is tending with its approval is the land-mortgage bank scheme, so conspicuously successful in European countries during recent years, and taking form in Congress through the provisions of the Bulkly-Hollis bill. These banks are at present with us invariably the product of state legislation. They are subject to ownership by private corporations and, in some instances, use state facilities in carrying on their work. Although varying slightly in details in different localities, their methods of operation are universally similar and may be quickly described as endeavors to transform a farm's creditableness into a shape available for purchase by the investing public. This is accomplished uniformly in the same fashion, namely, by taking mortgages upon farms (the loans secured by these mortgages being in the interests of the borrower of the installment payment type) and upon the aggregate security of these mortgages selling bonds in such denominations as best suits the investing customer. The bonds run for a limited number of years and bear such a rate of interest as will enable the bank to make a profit between the interest receipts received upon its mortgages and the interest rate paid upon its bonds. These banks market their own bonds without the aid of a central institution and make mortgage loans over a limited territory.

Let us now turn to an examination of the fitness of these land mortgage banks in comparison with their rivals, the building and loan associations, to undertake successfully the handling of the rural credit situation. Building and loan associations were first organized in Philadelphia in 1831 by working men, and, as their name implies, they are credit-furnishing societies rather than credit accumulators like the savings banks. They are cooperative in form of organization, and their funds are obtained from loaners who are seeking long-time investments. They have already become so thoroughly established among our credit

handling agencies that most states have provided special laws for the incorporations of these societies and special methods for their supervision. Their growth has been phenomenal, the hand-book for the national gathering of these associations for 1913 showing an aggregate of more than six thousand societies with a sum exceeding a billion of dollars equalling their assets.

Both kinds of institutions we notice at the first glance are similar to each other in the important fact that their loans are repayable upon the installment plan—the land-mortgage banks using as an amortization scheme of arranging its installments while the building and loan companies employ the scheme of the sinking fund. The land mortgage banks, indeed, have a decided superiority over the loan companies in this matter of installments through the greater simplicity of the contracts which they offer to the borrowers. The extreme simplicity of the amortized installment arrangement which the land banks use may be quickly grasped by any one accustomed to paying debts, but the building and loan method of using stock as a means to offset a loan is novel, and its merits are only seen after much explanation. Indeed, it is authoritatively claimed that a governmental subsidy to building and loan associations could not be used to better purpose than in conducting an educational campaign by which people generally would come to understand these institutions.

The loan societies and the land banks have both at bottom identical purposes, since both are largely agencies for the collection of money for certain definite uses, but the loan associations do this by selling stocks, the land banks by the sale of bonds. Unquestionably, the well-known characteristics of each of these two kinds of securities act in a similar fashion when applied to loan companies and land banks as when applied to any other type of corporation. The purchaser of a bond looks primarily to the security of his investment. He wants an assured interest income together with certainty of redemption of his bond at maturity. The buyer of a stock, however, is willing to assume a risk in the hope of possible gain. He takes things on a contingent basis. He wishes to participate in the business itself and the building and loan societies may properly benefit from this fact that its members, being stockholders, may be expected to give their common institution its much needed asset of publicity, while this end is attained by the land banks only through the use of the customary advertising.

It is sometimes assumed that mortgage banks have an advantage over building and loan companies because bonds have a more universal market than have stocks—the bond buyer, it is claimed, being only slightly interested in the management of his company, may live anywhere, while the stockholder seeking the highest contingent returns must live in the neighborhood of his property where he may have over-

sight of the administration. Substantial devices exist, however, whereby the loan society may reach out for a wider market than would naturally seem possible—such, for instance, as the sale of paid-up stock or the change from a local into a national society. The marketing successes of the two sorts of companies may be further characterized by the observation that building and loan companies have already made their reputation with the public in this country and the governmental administrative machinery for their control has become well established. On the other hand, the land banks, to a large extent, are still novelties unknown upon the markets and must yet commend themselves to the public in order to sell their bonds.

In the vital matter of expensiveness of loans, building and loan charges for a long-time debt are doubtless lower than are those of the land bank companies because, while the interest charges upon loans will be the same in both cases, the building and loan system of using a sinking fund with which to cancel a principal gives the borrower the earnings of this fund and may therefore reduce his total indebtedness.

Some problems there are in which both sorts of institutions are concerned, and in the interests of a full presentation of our problem these common grounds also must be described. Both, for example, are similarly interested in the question of freedom from taxation. It seems a slight subsidy indeed to request at the hands of government that institutions having such laudable purposes as the furnishing of homes or farms to people should be exempted from the usual public burdens. This consideration indeed receives added force when we remember that homes and farms are the very kinds of property which governments enjoy taxing to the uttermost, so that the eventual issue from the work of credit companies is to increase the field of revenue receipts for governments.

The problem of standardization of type for both the loan companies and the land banks is one which presents many perplexities. No other merit is more frequently assigned to the federal bill for chartering land banks than the one that it gives a federal charter whereby all of these banks will be uniform throughout the land. This uniformity will of itself, it is claimed, give standing and reputation to the concerns involved, since application merely of the same name, not to mention other opportunities, to the same institution everywhere will develop public familiarity which will be invaluable for security marketing purposes. On the other hand, the proposition which is frequently made to have the bond selling for these banks performed by a single institution within each state is very vigorously condemned, since it is asserted this will allow no flexibility between different parts of the state having different degrees of economic development as to interest rates, time terms, commissions, etc. Evidently this problem of flexibility or uniformity is

one of much delicacy. The loan societies have tended always toward flexibility, and they have doubtless benefited from this adaptiveness. We find no uniformity of name, for example, among these societies so that the same type may be designated by a different title in every different locality. In New England, as a case in hand, they are Mutual Savings banks, here in the Middle West we name them Savings and Loan societies or Building and Loan societies indifferently; their business processes vary incalculably, seventy methods of premium determinations are in vogue and almost half as many for distributing profits. It is quite within the range of doubt that so much variety is necessary and it would seem clear that some of the benefits claimed from uniformity by the banks would apply to loan societies also should they conform more closely to a single type.

The suitability of building and loan societies for furnishing rural credit is indeed no longer a mere academic question. They have already entered this field, particularly in the state of Ohio, where a recent report from the secretary of state for the commonwealth shows that more than fifteen millions of dollars are loaned by these societies for the purchasing of farms. It has been the business of these associations everywhere from the start to find creditability in the laboring man and to allow the laboring man the enjoyment of his creditability. They will be equally successful in discovering the credit resources of the farmer. Credit is proverbially shy and credit relations which are to endure for a half generation or more will not be entered into as readily with some new creation of law as with some association which has already solved the practical problems involved in legal, political and business adjustment. Furthermore, since loan associations are invariably cooperative in character they will form still another opportunity for this species of associative activity which is now regarded everywhere as indispensable to the farmer's development.

Apparently it is regarded as imperative that Congress shall provide some source of credit to the agriculturist during its present session. Ought not our lawmakers to throw such support as they are prepared to give for the improvement of rural credits in the direction of building and loan associations rather than toward mortgage banks? As we have tried to show, loan societies are strictly American in their origin, are specialized to long-time easy payment loans, have become thoroughly adjusted to our legal system and business methods, are reputable and have shown practically their successfulness in performing the work at hand.

THE MENACE OF ACADEMIC DISTINCTIONS

BY C. G. AND C. B. MACARTHUR

URBANA

IT has been eleven years now since the late William James wrote in his incisive essay on "The Ph.D. Octopus":

America is thus as a nation rapidly drifting towards a state of things in which no man of science or letters will be accounted respectable unless some kind of badge or diploma is stamped upon him, and in which bare personality will be a mark of outcast estate. It seems to me high time to rouse ourselves to consciousness, and to cast a critical eye upon this decidedly grotesque tendency.

High time eleven years ago! No less urgent, certainly, has become the present necessity for such criticism. James continues:

As it actually prevails and grows in vogue among us, it is due to childish motives exclusively. In reality it is but a sham, a bauble, a dodge, whereby to decorate the catalogues of schools and colleges. . . . In the minds of presidents and trustees the Ph.D. degree is in point of fact already looked upon as a mere advertising resource, a manner of throwing dust in the public's eyes.

James probably meant to include with the Ph.D. degree not only other cherished differentiations between the learned and the "rank and file of the common people," but also those slighter differentiations within faculty groups which cause the teaching force of our universities and colleges to "play politics" as basely as any ward politician, though more subtly as befits their greater culture, and make men prostitute their talents to gain recognition from their superiors in rank.

We in America have made perceptible progress toward democracy, but at times it seems as though the fewer and less striking became the acknowledged distinctions in society, the more doggedly did man insist on being differentiated from his fellows. It is a very common characteristic, by no means confined to academic circles; nor does it, as we in academic circles should like to believe, pass us by. Even those of us who harangue about the absurdity of degrees and titles feel snobbishly superior to those who bow before them.

Any one now may enter the class of the so-called intellectuals; but once there, he must, on pain of ostracism or expulsion, don the garb of the new class he has entered at least once a year. Slowly and solemnly he must walk, clad in a sombre black having red, yellow, purple, green, and salmon pink decorations, a being set apart, by the grace of God and the aid of a mortar board, from his less intelligent fellows.

There has been of late a healthful breaking down of some class

defenses. The scientists and dramatists have routed the doctor a little way out of his mysterious sanctum. The minister, tired of being classed a member of the third sex, has shed his "Reverend" and his coat tails. To be sure many people still have a confidence in their family doctor that would flatter the Almighty, and there is still many a woman whose awe for the minister can find no expression save in bounteous chicken dinners.

Among the academic class there are, to be sure, men of simple purpose, who have no desire to stand apart from their fellows, who ask only the stimulus and satisfaction of applying their accumulations of knowledge and adroitness with problems to the new and vital situations of our day. On the other hand, there are among this class those whose snobbishness tends greatly to limit their usefulness. Every class, of course, has its snobs; but when exclusiveness crystallizes into institutions—external symbols which the entire group accepts and the newcomers into the group are compelled to adopt, there is grave danger.

One wonders why the academics should be so jealous of their titles and honors and position. Business men manage without titles; likewise engineers and many others in professions calling for much training and keen intelligence. Yet here is a group who presume to set themselves apart and insist on being addressed in terms equivalent to "Your more or less Intellectual Highness." The mild insistence on the use of such terms by students, of course, might have its foundation in a desire so to overawe the student that he dare not do a disrespectful amount of independent thinking, nor call into uncomfortable question the authoritative statements of his lecturer; but why exact this deference from fellow townsmen or academic brethren?

This jealous guarding of titles and honors by the academics is, in part at least, due to an ideal which is developing in this democracy of ours—the ideal of an intellectual aristocracy. We have foresworn aristocracy of blood; we are outgrowing aristocracy of wealth; but there have been few to cry out against this new aristocracy that is being foisted upon us.

"Let those of us who know most," say the followers of this ideal, "determine what is best for all the rest of you. We know what the world has already attempted, what has failed, what has succeeded. Let us direct your efforts." One professor's wife complained, "It's a great pity the townspeople take the attitude they do; they not only refuse to take our advice about how the schools should be managed and the garbage collected, but they seem actually to resent our thinking we know best."

The academics are fostering the ideal of an intellectual aristocracy for exactly the same reasons that make a king favor aristocracy of birth, or that throw Wall street into a panic at the thought of federal control of our currency system. Members of each class are fully persuaded that it is best for society as a whole that their influence and power should

be dominant. It is amusing to notice that though the lines of demarcation drawn by any ambitious group between themselves and other groups vary, those lines have this in common—they never exclude those who draw them from the higher classes.

Such an attitude—that of the intellectual aristocrat—makes for inefficiency in a teacher, of course; for it implies lack of respect for the mental power of most of one's students, with resultant dogmatism.

We have gone mad these days, in university circles no less than in business, over specialization and efficiency. In so far as we are true democrats we must believe that the highest efficiency of any people is to be measured by the efficiency of each individual of that people. And that on no account means an efficiency which falls short of individual initiative and independence of thought. Dogmatism is intolerable in any institution, particularly intolerable in an institution on which the future of our democracy rests as it does on our universities. They need to make sure both that they are not dogmatically instructing students as to what they shall believe, and that they are not encouraging the idea of the divine right of one class to dominate another because of special training or technical information. We are struggling too severely these days to bridge the gap in sympathy between the capitalist and laboring classes to allow opportunity for other breaches in mutual understanding and sympathy to develop. It is because the childish academic distinctions that run riot in our universities to-day tend to widen the gap between the so-called intellectual classes and their fellows that they "give us pause."

In his "Great American Universities," Slosson unburdens his soul after this fashion:

So it is with self-distrust and pure despair that I dismiss the subject after recording my personal opinion that a dozen mortar boards on the campus are more of a menace to democracy than a million-dollar endowment from a trust magnate. For no man can tell what use is going to be made of his money after he has let it slip out of his own hand, but a widespread spirit of exclusiveness and arrogance, such as find expression in ceremonies and costumes, can not be eradicated.

Aside from titles and "ceremonies and costumes" by which the academics proclaim their separation from the rest of the world, a technical vocabulary is in some measure responsible for this separation. A man may have a democratic, cooperative attitude in his secondary interests, but let another man speak a new truth in his chosen field, and he fails utterly to understand or credit him, if the other is unable to use the technical terminology of his science. We seldom realize how far from untrained minds the customary logical arrangement and terminology of a subject removes the academic. He frequently does not need tassels, or stripes, or a succession of capital letters after his name to make him immune to the ideas of the man of the street. This failure

to understand the other's vocabulary makes more difficult not only the acquisition of new ideas in their crude state by the academic, but also his dissemination of knowledge.

The profession of teaching is nearly always underpaid, and men have perhaps felt some compensation in the way of honor was due them. Society seems to say: "Gentle sir, we recognize your noble, self-forgetful spirit which is content only to teach and inspire our youth with no hope of reward other than a bare living wage. We are not ready to pay you more, but we will cheer you on by giving you high-sounding titles." The consequences of this policy have, however, been disastrous. By and by the self-forgetful man begins to listen for those titles; then to take to himself honor for his missionary spirit.

The truth of the matter is, much of the spirit of self-sacrifice has vanished from our university faculties to-day. Why, then, this additional compensation? It is absurd to call a man self-sacrificing because he prefers freedom for productive work, for self-expression, to the rewards of the business world. One should as appropriately honor a fan for his sustained devotion to baseball!

Eager as the academic is to keep at respectful distance the man of the street, this eagerness is frequently less fierce than his zeal for discrimination between himself and other academics. The contagion wards in a hospital are isolated with scarcely more care from one another than are the various ranks of academics, in catalogue (we make grateful exception of the University of California) and processions. Titles are jealously guarded and punctiliously used.

This zeal for maintaining gradations in rank extends even to the circles of the in-laws. One professor's wife who found she must curtail her visiting list did it by cutting off every woman attached to a man whose rank was less than that of a full professor, thus sparing her judgment the effort of evaluating the women, since the university had already carefully graded the men whose family interests they shared. And in two of our middle-western universities we are assured it is considered bad form for the wife of a man of lesser rank to pay the first call on the wife of a man of higher rank! We are not yet informed as to whether the distinctions are so carefully maintained by the children, servants, cats and dogs of the various families or not.

The distinctions one class cherishes seem merely absurd to people in other professions. We venture to say that no blacksmith, for instance, could fully appreciate these subtle discriminations in vogue in academic circles; and we academics, in turn, would probably rate blacksmiths rather much on a par. We might prefer one blacksmith to another, might think one had a stronger right arm than another, or even a stronger mentality; but if some of us were getting up a June procession of blacksmiths we probably should not trouble to put differing numbers of stripes on their sleeves, nor bother about adjusting the tassels on their

caps—if they could be prevailed upon to wear a thing so feminine—to make sure those of a certain grade of efficiency wore them hanging down into their right eyes, those of inferior grade into their left eyes.

Yet there lurks in the soul of at least one blacksmith this same craving for discrimination from his fellows that is so demoralizing a factor in academic circles. On Cottage Grove avenue in Chicago one may see his sign, "Fitzgerald"—the initials are gone from memory—"Fitzgerald, Professor of Horseshoeing." His shop is out toward the university; perhaps the infecting bacillus escaped from the confines of the gray stone walls. It is possible his motive for insisting on the distinction between himself and ordinary blacksmiths is merely a commercial one. But the bacillus for that disease might also have come from within the gray stone walls.

Two institutions for the perpetuation of this attitude of intellectual snobbery among even the elect are the honorary societies of Phi Beta Kappa and Sigma Xi. The former depends for its membership in most universities and colleges on the students who outstrip their fellows in grade getting. Any one who has been through one of our higher institutions of learning appreciates the ability this connotes—ability to memorize the lesson daily assigned, sensitiveness to idiosyncrasies in the instructor, so that in examinations one may return exactly the sort of replies the instructor expects, with warm appreciation of what has evidently been the teacher's hobby.

Sigma Xi, the honorary scientific society, prides itself on admitting to membership only those who have shown ability in some field of original research. Supposing for the instant that no Sigma Xi group estimates candidates by any lesser standard, one is still left wondering how long we are to consider this childish prize-offering necessary to faithful truth-seeking. It is appalling to note the pages of honors and prizes listed in many university catalogues. President Jordan makes this interesting comment: "Prizes, honors, badges and degrees,—all these have no necessary place in the machinery of higher education. If our universities had grown up in response to the needs of the people, not in imitation of the colleges of England, we should never have been vexed by these things, and never felt any need of them."

The newly rich blatantly announces his superiority over his fellows by his flaming necktie, flowery vest, heavy motor; with the academic these signs give way to the less blatant but no less effective Phi Beta Kappa or Sigma Xi key dangling on fob or necklace.

As has been repeatedly pointed out by other writers, our universities are based on autocratic rather than democratic organization, with the executive forces, of course, dominant. Now the executive mind inclines much more toward order than toward flexibility; it wants things definitely discriminated from each other, so must have definite rankings for students and faculty. It goes on with its efforts to tabulate mental

ability, preferring in all too many cases to sacrifice the unusual to the usual, the individual variation to the norm, rather than to let its careful gradations of rank be disturbed. The effort is to reduce to mechanical terms what is organic.

And because our universities must have tangible standards in tabulating members of the faculty, they have come to judge a man's worth by the number of pages of printed matter per year issuing from his pen rather than by the number of ideas issuing from his brain; by his reputation and consequent value in swelling university enrolment totals; by the number of his degrees—as though it were not difficult enough to get at the genuine worth of a man without having to excavate beneath title upon title and degree upon degree in the university catalogue, or without being distracted by his ability to display a new style hood for every Commencement procession.

The effects of this furor for tabulation are no less unfortunate on students than on faculty; the marking system with its emphasis on memory work and on appearing well in the eyes of another man, the rigidity of requirements for entrance and for graduation, and all those attendant evils best described as a tendency toward uniformity rather than individualization in our whole educational system,—these may all be traced to this zeal for standardization.

As a half-way house between students and faculty stands the Ph.D. degree. To the student it marks the culmination of his effort, and in some universities its attainment is a prerequisite to eligibility to membership on the faculty. Only men of unmistakably intellectual tastes—whatever that may mean—of originality, actuated by a love of truth and its pursuit, and believing such pursuit in itself a sufficient reward,—only such, presumably, are permitted the ordeal of the third degree.

Yet in its influence on students and faculty alike, much that this degree stands for is pernicious, and its acquirement is beset with evils. In these days a student soon sees the commercial value of a degree and is likely to come to his future work with hope of winning honor for himself rather than with the desire to do well some piece of work and to contribute to the world's knowledge. When he sees how difficult it is for a man to obtain opportunity to work in a university unless he can write those three magic letters after his name; when he sees, as sometimes happens, a man admittedly successful as a teacher and scholar dropped by a university because he lacks those three letters, the student is quite likely to submit to the system and take the degree, though he may be keenly conscious that half the time spent in so doing he could have used to better advantage. His work is interrupted; his ideal shifts from work for the joy of finding new truth to the temporary memorizing of useless facts, always with an eye to the questions each of his examiners is likely to ask. Instead of reviewing to get a large grasp of

a subject, he usually has in mind, "Such and such a thing is M.'s hobby; I'll cram on that"; or, "S. has been reading up on this subject the past few weeks; he will ask something about that."

Individual investigation is supposed to be a prerequisite to the obtaining of the Ph.D. degree; but the pressure for productive results from the faculty has become so strong on the part of the executive department, and competition for recognition so keen among instructors, that in, we venture to say, a majority of cases this individual and original problem required of the candidate for the Ph.D. degree is one laid on him by his instructor, and is often merely a portion of a large piece of investigation the instructor parcels out year after year to his various students. In many cases the instructor is the only one who has a grasp on the larger problem, who understands it in entirety. The result of this practise is that the student is drilled as a technician rather than as an original investigator. He fails to see new problems for himself, and frequently leaves the laboratory in which he has worked as a student without the lure of problems ahead to be worked out. In the midst of all our agitation for conservation, we may be forgetting to conserve our greatest resource—power to do creative work of great originality, and this in the making of young Ph.D.'s, where we flatter ourselves we have best preserved it.

Instead of keeping such an ideal alive, too many of our so-called intellectual leaders have been caught by such childish and tawdry symbols as tassels, stripes, capital letters and the sight of their names in print. They have come to prefer honor from their fellows to self-approval.

This has led them not only to strive for reputation themselves, but to give credence only to the man who speaks authoritatively and from the heights of renown. Their acceptance of a new idea too often depends on the prestige of the man who has uttered it.

Prostitution of talent and character, the development of an intellectual aristocracy in a democratic land, an absurd clamoring for petty honors, increasing gaps and misunderstandings between classes and professions, dogmatism, commercialism, the inculcation of false ideals in young students, dependence on reputation rather than on genuine worth, emphasis on standardization rather than individualization in education, the effort to serve two masters—truth and the man immediately above one in rank, be he teacher, department head or president—all these are evils attendant upon our present system of academic honors and badges.

In contrast to these conditions, hear the ideal of William James:

Our universities at least should never cease to regard themselves as the jealous custodians of personal and spiritual spontaneity. . . . They ought to guard against contributing to the increase of officialism and snobbery and insincerity as against a pestilence; they ought to keep truth and disinterested labor always in the foreground, treat degrees as secondary incidents, and in season and out of season make it plain that what they live for is to help men's souls, not to decorate their persons with diplomas.

THE FREQUENCY OF DREAMS

BY PROFESSOR CARL E. SEASHORE

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IS there any dreamless sleep? I venture the assertion that probably all persons dream all the time when they are asleep (and sometimes when they are awake). There is perhaps no dreamless sleep.

Since authorities are about equally divided on this mooted question, it is necessary that a brief summary should be made of the grounds upon which our assertion rests. Such grounds may be seen in four directions: the observation that inability to recall a dream is no proof of the non-existence of the dream, certain theoretical considerations, experimental proof, and spontaneous expression of dreams. Many other lines of evidence might also be brought to bear. The proof must necessarily be inductive, and therefore can be only cumulative; the most that we can prove is a high degree of probability of the truth of the proposition.

The notion that dream-consciousness is not continuous in sleep rests essentially upon the memory test, the feeling that, since we recall dreams only occasionally, we have had only occasional dreams. We must therefore first examine that proof.

Replies to questions as to the frequency of dreams run somewhat like this: "Very much every night"; "Nearly every night"; "A dozen times a month"; "Hardly ever"; "Never." But such reports tell us nothing about the frequency of dreaming, for they refer only to the frequency with which dreams are remembered; and we know now that normally dreams are not remembered. Only the exceptional dream is remembered. If one has had a hundred dreams during the night, he may or may not remember one or more of them. Whether or not a dream shall be remembered depends upon its coherence, the strength of associational ties, the depth of sleep, the habit of recalling dreams, and many other similar conditions. As a rule, dreams are not remembered; mental development and efficiency in waking life are conditioned upon our freedom from the burden of consciousness of the massive apparent chaos of dream life.

We remember only those experiences which are coherent, clear, and rational—experiences that are more or less individualized and have meaning with reference to waking life. The vast mass of dreams are too fragmentary, too fleeting, too much thrust upon us as an undifferentiated jumble—in short, too meaningless to be remembered. Of the dreams which have meaning, we remember only those which are recent,

primary and strong, and stand in striking congruity or incongruity with our dominant feelings. Most of the coherent dreams are wanting in these respects and are only distantly relevant to waking consciousness. Of the relevant and coherent dreams, we recall only those for which situations in waking life chance to occur in such a way as to establish bonds of association that shall extricate them from the mass of unrecognized dream traces. You wake up in the morning after a sound sleep and may not be able to recall any dream; but the moment you stoop to lace your shoe a vivid dream image flashes up and you recall that you dreamed in the night of walking barefooted in the snow. Had there been no awareness of the shoe, this dream of the want of a shoe might not have been remembered. On the whole, there is a slight chance that situations in waking life shall so occur as to elicit the image of a dream which is sufficiently recent.

Even with all other considerations favorable, the ability to remember a dream is conditioned upon the presence of a habit of recalling dreams. The development of such a habit is on the whole undesirable; should a person remember all his dreams, he would lose his mind and be helpless; therefore the principle of natural selection tends to suppress dreams. The writer, like many other students of dreams, has found it advisable to abandon the intensive study of dreams because habits of observing and recalling dreams interfered with normal sleep.

The dreams which we remember come from light or disturbed sleep. The failure to remember dreams is roughly proportional to the depth of sleep. Sleep-walking, *e. g.*, occurs only in deep sleep.

Many apparently fabulous stories of feats in sleep-walking are found true. A college student formed the habit of getting up in sleep, dressing, walking down to the Mississippi River, three quarters of a mile distant, undressing, taking a deliberate and enjoyable swim, dressing, walking back to his room, undressing, and retiring, only to wake up in the morning without the slightest inkling of remembrance from the escapade of the night. But when his friends constituted themselves detectives and awakened him suddenly in the act, the whole performance stood out clear to him in his memory. Sleep-walking is dream-action. If a sleep-walker is allowed to return to bed without being awakened, he will have no memory of the dream action in the morning.

In deep sleep we may do anything we could do in waking life, and even more, for the dreamer may become a distinct second personality, free from some of the limitations of the waking personality. Thus we have in dream action evidences of the most amazing complexity in the deepest undercurrents of mental life, under the very conditions which preclude the possibility of memory of the dream.

In view of such considerations, it is clear that from the negative point of view, arguments for dreamless sleep on the basis of the memory test can have no valid foundation.

Turning then to our theoretical proof, we find a strong argument in the generally recognized correlation of mental activity with certain neural activities. There are many theories of this relationship, but for the present purpose we need not assume that this correlation is complete, nor need we inquire into the nature of the causal relations; the fact that there is an observable correspondence is enough. We know from physiology that no part of the nervous system is ever wholly at rest. With the exception of the eye, all the senses are open in sleep; taste, temperature, and tactual stimuli are often conspicuously present in sleep. It is difficult to conceive of any condition in which this flux of sense impressions, should be absent. All these sense impressions in sleep cause dreams, and the central association mechanism is constantly at work weaving an intricate network of relationships among these impressions thereby giving them meaning, however far-fetched. Indeed, the very closing of the eye as in sleep is conducive to an increased play of visual impressions, for the internal stimulation gives rise to the so-called retinal light, which may be very brilliant, and is always seen in a more or less gorgeous kaleidoscopic motion. It has been well called the stuff that dreams are made of.

Stimuli through ear, nose, skin, muscle, and even the closed eye, affect the mental organism on the same principle as in waking life. Internal stimuli act not only upon the sense organs, but also directly upon the brain and other nerve centers. Pressure caused by the rush of blood, metabolism, and other mechanical stimuli arouse nerve impulses. Probably chemical, thermal and electrical action within the body tissue may stimulate nerve elements directly. Theoretically such centrally aroused nerve impulses have their mental correlates. On the theory of concomitance, we must therefore assume that there is a continuous stream of mental processes which correspond more or less to the continuous activity of the nervous system. In sleep such mental processes are, of course, subliminal: they are dreams.

In short, on the theory of correspondence between certain mental and neural processes, the continuous impressionability of the senses and the constant stimulation within the central system itself point to an uninterrupted dream activity in sleep.

Experimental procedure has brought direct proof which is cumulative and has revealed no exceptions. Proceeding on the assumption that a given sense stimulation will cause a particular dream, Alfred Maury many years ago made experiments of which the following are typical:

First Experiment.—He caused himself to be tickled with a feather on the lips and inside of the nostrils. He dreamed that he was subjected to a horrible punishment. A mask of pitch was applied to his face, and then roughly torn off, taking with it the skin of his lips, nose and face.

Second Experiment.—A pair of tweezers was held at a little distance from his ear, and struck with a pair of scissors. He dreamed that he heard the ringing of bells; this was soon converted into the tocsin and this suggested the days of June, 1848.

Third Experiment.—A bottle of eau de Cologne was held to his nose. He dreamed that he was in a perfumer's shop. This excited visions of the East, and he dreamed that he was in Cairo in the shop of Jean Marie Farina. Many surprising adventures occurred to him there, the details of which were forgotten.

Fourth Experiment.—A burning lucifer match was held close to his nostrils. He dreamed that he was at sea (the wind was blowing in through the window), and that the magazine of the vessel blew up.

Fifth Experiment.—He was slightly pinched on the nape of the neck. He dreamed that a blister was applied, and this recalled the memory of a physician who had treated him in infancy.

Sixth Experiment.—A piece of red-hot iron was held close enough to him to communicate a slight sensation of heat. He dreamed that robbers had got into the house, and were forcing the inmates, by putting their feet to the fire, to reveal where their money was.

Seventh Experiment.—The word Leonore was spoken. On awaking, he recollected this word, and found that he had attributed it to one of the persons who had conversed with him in his dream.

Eighth Experiment.—A drop of water was allowed to fall on his forehead. He dreamed that he was in Italy, that he was very warm, and that he was drinking the wine of Orvieto.

Ninth Experiment.—A light, surrounded with a piece of red paper, was repeatedly placed before his eyes. He dreamed of a tempest and lightning, which suggested the remembrance of a storm he had encountered in the English Channel in going from Merlaix to Havre.

In each of these experiments the dream could be reproduced because the dreamer was awakened in the very act. Had he been allowed to sleep until morning, there would have been but little likelihood of the recalling of the dream. The significant fact is that, allowing for the realism and the dramatic form of the dreams, experimental procedure confirms the theory that every sense impression tends to produce a corresponding dream. And, as we have noted above, the senses are all responsive in sleep, there is no silence, no darkness, no freedom from the impressions of odor, taste, touch, strain or temperature. This continuous stimulation of the senses results in a continuous flux of dream flashes, many of which lead to extended dreams.

The probability of dreams from a given set of stimuli is increased beyond that of analogous situations in waking life by the fact that the dream is not a true representation of the stimulus, as the waking impression is supposed to be. When awake, you may merely note a slight taste of bitter in the mouth; whereas, in the dream, the same condition on the tongue might make you dream of going through some awfully bitter experience, of being poisoned, or of eating some disagreeable substance with distressing consequences.

It is possible to enter into conversation with a sleeping person; and,

if the sleeper is not awakened at the time, he is not likely to remember anything about it. The replies are proof that the apparently dreamless sleeper hears the conversation, understands it, and fits his words to the ideas in mind. It is claimed that talking to a sleeping person is an effective way of instilling ideas which it is desired should work themselves out in the waking state. The method has been employed in the breaking up of bad habits and in the effort to create desirable habits.

Hypnosis may be employed to bring out evidence of dreams from apparently dreamless sleep. If a person wakes up after an apparently dreamless sleep, he may be hypnotized and given the suggestion to recall dreams from that sleep. There is such a kinship between the dream state and the hypnotic state that it is quite possible to conjure up in the latter the experiences of the former. The report of such dreams may be checked and verified, in part at least, by controlling conditions for production of dreams experimentally in the sleep, and then checking up the hypnotic report by these known causes of dreams.

Waking suggestion may be employed, some think, even more effectively. By Freud's method of psychoanalysis the dreamer is put through a sort of sweat-box process, not necessarily unpleasant, in which the inquisitor, by following clues progressively revealed, discovers stimuli which step by step lead to the effective associations that may recall to memory dreams not otherwise recallable.

A most interesting extension of the field of dream interpretation has developed in recent practice of psychoanalysis. If the patient is unable to recall any dream, the physician asks him to invent one, and it is found that such an imaginary dream partakes of the nature of a real dream; *i. e.*, cause and effect may be traced and it may be "interpreted" as if it had been a real dream.

The experimental evidence, then, tends to prove that dreams are caused by natural stimuli as sensations are caused in waking life: given a sense stimulus, we may expect a dream to follow. The fact that a dreamer may carry on a dream conversation, or influence the formation of habits by suggestion in sleep, is proof of highly complex and rationalized activity in sleep, of which the dream carries no trace into waking consciousness. The experiments with hypnotic suggestion and waking suggestion add convincing evidence to the belief that, whenever we have adequate means for the testing of a given moment of sleep, we find it occupied with dreams.

The theoretical conviction thus strengthened by experimental tests is further fortified by close observation of spontaneous expressions of dreams. It is a law of psychology that what is in the mind tends to express itself in appropriate action, even though only inceptive and normally only faint. A skilled observer watching a sleeping person may be able to observe uninterrupted evidence not only of a continuous

stream of dreams, but also of rich complexes of dream conflicts. If this observation be done with the expert skill of a so-called mind reader, most marvelous reports may be drawn from dream-life through the unconscious reactions, especially the rich play of facial expression, which is eloquent language. The observer also "reads" the environment with the same skill and, by associating the continuous flow of sense stimuli with the psychophysical expression, his observations are reduced almost to experimental control.

It may be said that these contentions prove too much in that they prove the presence of dream consciousness in the waking state. That is granted, and it is an important fact. We dream a great deal on the ordinary rounds of duty. One who is trained in psychological observation of dreams will catch himself frequently in moments of dream-consciousness, sometimes infinitesimally short and in the midst of mental application. On opening a Christmas package, *e. g.*, skilful retrospect would probably reveal to him glimpses of himself in childhood scenes and he might notice that in spite of the self-conscious and joyous activity of the moment, a sort of other self, split off from the waking self, joined these momentarily merging flashes from dream-life into continuity. The writer has observed dream flashes in his own mind, even while lecturing before a large audience. More significant, however, is the presence of that broad stream of subconscious impressions which underlies waking consciousness but passes unobserved. These subconscious impressions in waking hours have much in common with dreams.

The theory of dreamless sleep came into vogue at a time when man held a crude and all too simple view of the mind. Experimental psychology has deepened insight and broadened our view of mental life, ever revealing more and more aspects before unobserved. Only a few years ago, it was thought that to have an illusion or an hallucination was of necessity to show mental weakness. Hallucinations and illusions were therefore supposed to be rare objects of curiosity. Now we know that hallucinations and illusions are normal and ever present in all well-regulated mental life. It has been shown that the conditions which cause illusions and hallucinations are as a rule fundamental and essential conditions of normal mental power. The very principle which enables us to see true perspective in one situation leads of necessity to illusion in many other situations. Now, the man who asserts that his friend has been subject to an illusion, as if he himself were exempt, is the man who asserts that he dreams only occasionally. It may be safely maintained that the authorities who defend the theory of dreamless sleep espoused this theory before the recent notable advances in our scientific knowledge in psychology of cognition were made. The more we study dream life in the light of scientific method in psy-

chology, the more the idea of the ever presence of the dream in sleep grows upon us, not as a result of more and more observed cases only, but rather as a logical inference from growing knowledge of the operation of mental law.

The arguments advanced in support of the continuity of dream life imply and lead to certain interpretations of the nature of the dream, which give it a true setting in an evolutionary and naturalistic conception of the mind and give us a deeper insight into the actual richness and significance of dream life.

Conscious memory follows only a very small part of our waking experience. No one can recall more than an infinitesimal part of the images and ideas which flit through his mind in a day. Watch the flow of free association in your own mind for ten seconds. The display of ideas and images in their rough-and-tumble struggle for recognition is so rich and rapid that no one can speak fast enough to name them as they pass upon the arena of consciousness. Such a display goes on in a subliminal way, while consciousness is directed elsewhere. There is in all our conscious life a rich encircling fringe of this free association, but we have acquired some power in keeping this "fleeting show" subliminal because that is conducive to sanity and mental efficiency. A student asked to observe it for the first time tends to perceive but little following, this habit of suppression; but soon he finds himself in the position of one who, at a glance, notices but a few stars and attempts to count them; the more he tries to count, the more the field of vision tends to fill up with the countless.

The more absent-minded we are, the more coherent and prolonged these free associations become. The step from absent-mindedness to light sleep is in the same direction and is no larger than the step from active attention to absent-mindedness. These free associations constitute our dreams. Free from the limitations which operate in waking life, free even from the bounds of waking imagination, free association holds full sway and winged fantasy is at her best. Dream fantasy has moving pictures outdone, for the prevailing dream type is that of the flash-picture or snap-shot, and sleep affords the best condition for richness of setting and rapid change of scene. How little of this rich dream life we actually remember may be realized if we consider that a dream which in the recall may be represented as lasting an hour may be but the conscious elaboration of what in the actual dream was merely an instantaneous flash image.

The theoretical considerations discussed above are also replete with implications in regard to the nature and meaning of dreams. The dreamer is *en rapport* with the environment, for dream consciousness is responsive to the play of the senses, and dream apperception, representing all past experiences, takes in, modifies, interprets and responds

to impressions, weaving them into the web of dream personality. If then it is true that dream life is a part of the same substratum of mental activity that underlies waking consciousness, it follows that the dream impressions and the dream elaboration continually modify mental content just as the subliminal impressions of waking life do, but, except for the operation of the principle of recency, with vastly greater variety of impressions and effectiveness of result.

Experimental procedure in the production and observation of dreams also enriches our concept of dream nature in that it enables us to set crucial tests and observe details which may serve as a basis of generalization. It not only helps to convince us of the continuity, but reveals and confirms the operation of natural law, so that we realize that, although the dream operates in flagrant violation of the principles of time, space, reality, and cause and effect according to the standards of waking consciousness, it nevertheless flows in accordance with natural law in every respect and at every stage. Every dream fantasy—even every dream fragment or flitting image—occurs in accordance with the principle of cause and effect and is a phenomenon in mental nature just as truly as a blade of grass is a phenomenon of organic physical nature. From this point of view the dream is a chaos only in the same sense that the masses of stars are a chaos. Both are organized, the stars a macrocosm, the dream a microcosm.

With the point of view developed, after exclusion of irrelevant evidence and the acceptance of theoretical and experimental evidence in support of the continuity of dream-life, we are prepared to read meaning into the expression of dreams. The fact that our twitchings, inceptive speech movements, and even sleep walking occur as an expression of the dream is insignificant in comparison with the related fact that the dream expresses itself in our waking life. It not only modifies dispositions which result in feelings, attitudes, moods and impulses that characterize our waking consciousness, but often a specific dream determines our opinion, emotion, memory or decision in the same way as if the dream experience had been an actual waking experience. This is quite as true for the dream that is never remembered as for the dream that is recalled, and, as a rule, we are not aware of the source of such influence.

THE SIGNIFICANCE OF VENOMS

By W. M. WINTON

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"A WEED," said Webster, "is a plant for which we have found no use." To be exact he should have added: "except in medicine"; for the oldest, and, until recently, the most empirical of the sciences has been the dumping ground for all products both plant and animal which had no other possible use.

In no case has this process been more persistent than with those products which have a marked physiological effect. It is to this persistent experimentation that we owe nearly all of the drugs of modern medicine. The venom of poisonous snakes has not been exempt, despite its great virulency. The facts that it retains its power when dried and powdered and that it is wonderfully uniform, and thus lends itself to a sort of standardization, have made it subject to no little exploitation. Had this exploitation been started twenty years earlier in the history of medicine, doubtless we should now have many records of "cures" resulting from its use. It came, however, at a time when the medical man had learned to be wary of new drugs, except those whose physiologic usefulness could be demonstrated.

Snake venoms from the other side of the therapeutic shield, that is, as agents to be combated rather than as medical ammunition, still hold interest to the point of fascination. In America this interest is disproportionate to the importance of its subject. In many regions all snakes, beneficial ones as well as venomous ones, have been exterminated, practically at least. It is true that along the southern Atlantic and Gulf coastal plains, the danger to man from the ever-present and vicious moccasin (*Ancistrodon piscivorus*) is a factor of some importance; and, in the southern part of the Rocky Mountain region, the western diamond-back rattler (*Crotalus atrox*) probably will not be exterminated for several decades. Elsewhere danger from snake bite is almost negligible.

Lest the statement in the last paragraph bring on my head a storm of protest, I shall mention a fact known to all naturalists; and that is that most snake bites are from non-venomous snakes. The colubers of the middle west are very belligerent serpents, and attack with satanic fury. Because of the hazel brown markings any member of this group is popularly branded as a "copperhead," a name which properly belongs to *Ancistrodon contortrix*, a truly venomous reptile, but a small snake and

seldom or never found in plowed fields where the colubers go in their search for rodents. The region inhabited by the deadly moccasin is also frequented by enormous numbers of the red-bellied water snake (*Tropidonotus taxispilotus*) which is almost always called a "moccasin." The bite of this snake is harmless, aside from the actual mechanical injury, which may be considerable. Ditmars says of it: "It is in disposition one of the most ugly of American snakes." This is a mild statement. It is the experience of the writer that this water snake is the most depravedly vicious of all wild animals.

Do not these and other cases of errors in classification account for the success of some of the bizarre treatments which have been reported, some of them, to be frank, by even high-class medical men?

Venomous snakes have long been grouped according to the action of their venom. One extreme is represented by the rattlesnakes, whose venom is powerfully hemolytic, and acts on and through the circulatory system. The other extreme is represented by the cobras, asps, etc., whose venom acts much more rapidly and affects the nervous system directly. Noguchi refers to the two types of venom as "hemotoxic" and "neurotoxic."

Of more than passing interest is the fact that the tiny coral snake (*Elaps fulvius*) which is found in decaying logs and similar places in this country, carries a venom which is, as several workers have shown, qualitatively closely similar to that of the deadly cobra. But its sluggish and retiring disposition together with its small size make it inconsequential.

The moccasin and the copperhead, both members of the genus *Anistrodon*, have a venom which seems to contain a little of the neurotoxic element, but its principal effect is much like that of the rattlesnakes.

There are, furthermore, a few small mildly poisonous snakes in America known to naturalists as Opisthoglyphs, because their fangs are grooved instead of tubular.

Despite the fact that the rattlesnakes contain two genera and a large number of species and vary greatly in color and general appearance, the natural history of American poisonous snakes is quite simple. The moccasin and the copperhead have exactly the same markings; but the former is very much darker in color, the pattern sometimes almost obscured.

Our *dangerous* snakes, then, may be said to be: First, those bearing a rattle; second, those having a series of dark brown hour-glass-shaped markings on a lighter brown background.

A further consideration to be borne in mind is that the venom of all of these is of the deoxidizing hemolytic type; and the standard potassium permanganate treatment has never been improved upon. The

Calmette anti-venomous serum widely advertised and sold by sporting-goods houses, while extremely useful against the effects of Oriental snakes, is useless in America. A limited quantity of anti-crotalus serum is put out by the Rockefeller Institution, but under experimental conditions this is said to be of rather doubtful value because of the large amount which must be used.

For some years the writer has carried on, intermittently, some investigations in connection with popular beliefs regarding the slightly venomous properties of certain snakes not generally considered poisonous by zoologists. The persistence of some of the rumors, and their confirmation in a few cases by medical men, gave him the idea that the presence or absence of the poison mechanism, grooved or tubular fangs and well-developed poison sac, may not always serve as a criterion of the reptile's potential venomousness. Unknown to the writer others, Alcock and Rogers, were carrying on similar investigations. No final results have yet been published; but the writer, at least, has been able in some cases not only to demonstrate the presence of a real toxic element, but actually to formulate quantitative terms.

Of course a snake which has not developed the proper poison mechanism for injecting its venom is not very dangerous, even if its saliva is quite toxic.

Weir Mitchell established many years ago a fact that had long been suspected: that the poison gland of a venomous snake is identical with the parotid salivary gland of mammals. Noguchi in his monumental work on snake venoms¹ has pointed out that this structure goes through quite an evolutionary series. To be brief: in the amphibia and certain reptiles, this gland is a pure mucous gland; and in the higher mammals it is a pure serous gland. In the poisonous snakes it is almost half mucous and half serous. The relatively high development as to size is undoubtedly a secondary adaptation to take advantage of the poisonous nature of the secretion.

The writer believes that in time it will be demonstrated that the transition, beginning with a simple recurved tooth, followed by the immobile grooved fang, and ending with the highly developed tubular and erectile fang, is also secondary and follows the development of the poison gland.

Furthermore, it would seem that the development of the neurotoxic element is also secondarily developed. Noguchi has shown that the division of snake venoms into hemotoxic and neurotoxic is a convenient, but arbitrary, arrangement. It seems that the fundamental substance is something of a hemolytic nature, always present, whose relatively slow action may be covered up by the neurotoxic element when the latter is present.

¹ Pub. 111, Carnegie Institution.

The old macroscopic distinction between serous glands and mucous glands is that serous glands are those whose membranous surfaces are closed to the outer air (the lining of the blood vessels, the pleura, and the peritoneum); mucous glands are those whose membranous surfaces are exposed at some point to the outer air (the lining of the alimentary canal, the lining of the genito-urinary machinery, etc.). Of course, there are important histological differences also. With this distinction in mind, the comparative anatomy of the parotid gland is more than suggestive of the mode of origin of the venom of snakes. The writer believes that the toxic quality is due to a surplus quantity of deoxidizing or correcting element.

Transitions occur in the venomousness of salivary secretions. Besides the cases referred to, Alcock and Rogers showed that the parotid secretion of *Zamenis mucosus*, one of the blacksnake tribe and usually considered a harmless snake, is distinctly toxic and a moderate dose is enough to kill small mammals. The writer has confirmed this in other species of *Zamenis* and certain other snakes. It is a rather striking fact, however, that the saliva of coluber and tropidonotus appears to be not in the least poisonous.

As to transition forms above the snakes, certain small mammals are at present under suspicion; particularly the small black skunk (*Mephitis mesomelas*), the alleged "hydrophobia skunk," often incorrectly called the civet cat.

It is more than likely that certain small mammals which, in various parts of the United States, are popularly thought to be "reservoirs" of hydrophobia, owe their reputation to a hemolytic element in their salivary secretions. The symptoms resulting from the bite of such an animal are exactly what an uninitiated person expects in hydrophobia. In fact the symptoms are much more in accord with the popular conception of hydrophobia than is genuine rabies itself. This is aside from the long period of incubation which rabies requires, and which is often overlooked.

PROBLEMS ASSOCIATED WITH THE STUDY OF CORAL REEFS. II

BY PROFESSOR W. M. DAVIS

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The Theory of Submerged Platforms.—A modification of the theory that explains barrier reefs as veneers upon wave-cut platforms has been lately and briefly proposed. It regards the lagoon floors as platforms that were produced, while the central island stood higher than now, by some planation process or processes other than those concerned in the production of coral reefs, and then explains the reefs as veneers formed on or near the edge of the platform as it is submerged to its present depth. This theory has the merit of accounting for the embayed shorelines of the central island, inasmuch as the valleys which must have been eroded in it during the planation of the platform while the island stood higher, must have been partly drowned when the platform was submerged; but the theory has the demerits of tacitly postulating the absence of reef-building corals while the platform was being produced, and of leaving the processes by which the platform was produced unspecified. It would be easy to account for the platforms by subaerial planation, if the area that they occupy had consisted of weak rocks in comparison to those of the still mountainous central island, but there is not the least evidence that such was the case. Again, it would be easy to account for the platforms by marine abrasion, if corals were absent; but in that case the central island ought to be rimmed around by cliffs, as in the preceding theory. It is unreasonable to assume that corals were absent; for they have long been present in the coral seas, as is shown by the existence of uplifted and dissected reefs, having embayed shorelines and enclosed by barrier reefs such as the present theory seeks to explain. Moreover the form of the embayments on a good number of islands indicates that the depth of their submergence is decidedly greater than the depth of the lagoon upon which they open, as will be further shown when the glacial-control theory is discussed on a later page. The fact that certain barrier reefs are discontinuous and not always on the outer edge of the platform represented by the lagoon floor has been taken in support of this theory and as indicating that the platform has been produced by other agencies than those which produce reefs; but discontinuity of reefs and their displacement from the platform edge can be well explained by other theories also, such as the theory of subsidence, if it be assumed that subsi-

dence proceeds at different rates, now faster, now slower. If the fuller statement of the submerged platform theory, yet to be published, gives good ground for the absence of corals while the platforms were in the making, and reasonable explanation of the manner in which the platforms were made, it would have a better prospect of acceptance.

Darwin's Theory of Subsidence.—Let us now consider the theory formerly so popular, the theory of coral reefs which most of us learned at school or college, but which later came to be regarded by many able geologists as "no longer generally applicable." This theory supposes that the oceanic island or continental border on which a fringing reef is established intermittently subsides while the reef slowly grows upward: thus the fringing reef is transformed into a barrier reef around the diminishing central island, while the coral waste washed over the reef and the land waste washed down from the adjoining land surface, together with organic deposits formed in the lagoon itself, nearly fill the lagoon with horizontal strata; and later, when subsidence has gone so far that the central island has disappeared, the upgrowing barrier reef encloses an uninterrupted lagoon and is called an atoll. Here the associated problem takes on a new form. It is now necessary to work out the changes suffered by an island that is slowly submerged while its sur-

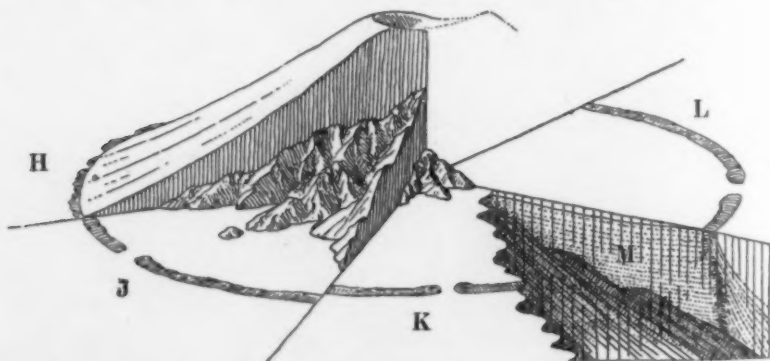


FIG. 13. DIAGRAM OF SUCCESSIVE SECTORS OF REEF FORMATION, as deduced from Darwin's theory of upgrowing reefs on subsiding islands.

face is eroded and a reef grows up around it. As before we begin in sector H, Fig. 13, with a large volcanic island, built up by frequent eruptions from the ocean bottom to some thousands of feet above the ocean surface. In due time a narrow fringing reef is established around its shores, interrupted at stream mouths where much detritus is washed down from the sharp-cut young valleys. Subsidence may have been going on slowly while eruptive upbuilding was going on more rapidly; now eruption has ceased, but subsidence is assumed to continue. What will be its effects? The effects of elaborate dissection

and moderate subsidence are shown in sector *J*; the effects of continued dissection and greater subsidence in sector *K*; and of complete submergence in sector *L*. This may be illustrated in another manner: During the progressive changes caused by erosion and subsidence, the simple initial shoreline of the central island consequent on eruption, shown in the background block of Fig. 14, must be changed to an indented or embayed shoreline consequent on the partial submergence of a dissected cone, as shown in the middle section of the figure. Eventually the island sinks out of sight and the atoll reef grows up, enclosing the uninterrupted lagoon, as in the foreground of Fig. 14.

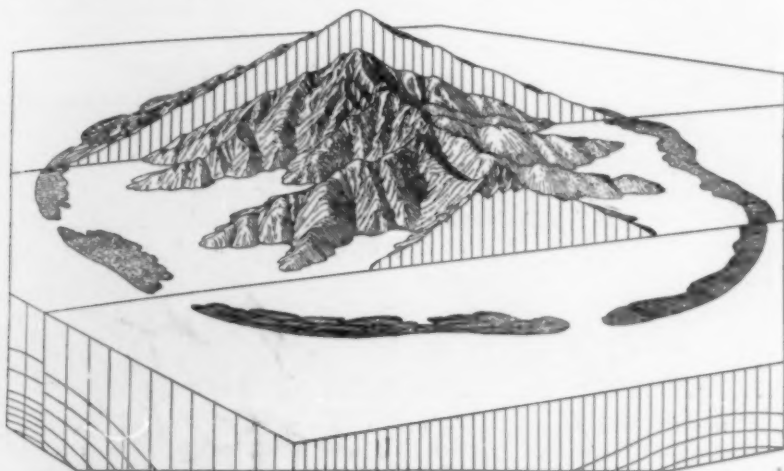


FIG. 14. BLOCK DIAGRAM OF A SUBSIDING VOLCANIC ISLAND IN AN OCEAN OF CONSTANT LEVEL. Background block, a high-standing island with a simple shore line bordered by a fringing reef; middle block, a partly submerged island with an embayed shore line and a barrier reef enclosing a lagoon; foreground block, an atoll reef around an uninterrupted lagoon over a vanished island.

The proportion of the several ingredients in the lagoon deposits will vary according to the size of the reef, the strength of the waves, the size of the island, and so on. The horizontal lagoon layers must rest unconformably on the eroded flanks of the subsiding volcano, as is shown in section *M* on the side of sector *L*, Fig. 13. Outside of the reef there should be a long, sloping talus, largely composed of coral fragments, except that opposite each pass or break in the reef, where the great volume of sea water that surges in over the reef-flat must find its escape, there should be a significant outwash of fine volcanic waste so long as the lagoon is of moderate width; for the lost volume of the initial volcano can not be represented only by the near-shore intermixture of volcanic detritus with the calcareous lagoon beds. The lower ends of the slanting layers of exterior talus thus formed must lie on the submarine constructional slope of the volcanic cone.

Two of these consequences deserve more emphasis. First, it must be understood that production of an indented shoreline, as in Fig. 15, by the subsidence of a dissected island is not a vague speculation; it is a geometrical necessity of the same order as that which defines the pattern of the conic sections; for the intersection of a fluted cone by the level surface of the sea must be an indented line. Second, if the subsidence is accelerated, the reefs may be incompletely built up to the



FIG. 15. THE EMBAYED SHORE LINE AT THE NORTHWEST END OF THE PARTLY SUBMERGED ISLAND OF NEW CALEDONIA; the water is part of the large lagoon enclosed by an extensive barrier reef. The farther shore line should be level.

surface, and appear only in narrow and discontinuous patches; or, if subsidence be over-rapid, the reef-building corals may be drowned by being submerged to too great a depth; if the subsidence is then retarded, a new fringing reef will be established on the submerged flanks of the island and will in time develop into a new barrier reef of smaller radius than before; in the early stage of the second reef the amount of subsidence indicated by the breadth of its lagoon will be much less than that indicated by the size of the embayments. But if it is an atoll that is thus drowned, it can not grow up until it is again uplifted nearer the surface or until it is built up to less depth by organisms other than reef-building corals. On the other hand, if subsidence ceases for a sufficient time, a barrier reef will widen by outward growth and inward over-wash, the deltas will be built forward and the lagoon will fill up; thus a broad, mature reef plain will, if the still-stand pause lasts long enough, more or less completely replace the narrow young reef and the lagoon. A brief and small elevation may occur at any stage, uplifting the reef a few feet out of water, when it will be attacked and dissected

by weather and waves, or submerged if subsidence sets in again. The reason that these consequences are so varied is evidently that subsidence is a much more variable process than standing still.

Success of Darwin's Theory.—Now how did this old theory fare? It gained immediate and universal acceptance. Was this because its author's experience was such as greatly to commend it? By no means; for Darwin was then a young naturalist, just returned from his first and only voyage of exploration. Did he consider other theories also? Yes, he did that most fairly and candidly; the theory of outgrowing reefs around still-standing islands, the theory of veneering reefs on wave-cut platforms, and several other theories were carefully examined, and critical reasons were stated for their rejection. Did the young naturalist deduce all the consequences of his theory, somewhat as above stated? No, not all; he stated several of them clearly enough, but he unfortunately made the serious error of overlooking one of the most essential consequences, namely the occurrence of embayed shorelines around the subsided central islands of barrier reefs; and thus failed to secure for this theory the confirmation that might have come from its success in explaining certain things that it was not invented to explain, as well as all the things that it was invented to explain. Why, then, was his theory received with so great favor? Evidently because those who accepted it were not in the habit of demanding that a successful theory should do something more than explain the things that it was invented to explain, and because they were satisfied on finding that it provided a simple, easily conceived scheme for correlating and explaining the numerous and varied facts that it was made to explain. Was that not enough to establish it? It seems to have been enough, as long as the theory had no serious competitors; for it was not only universally accepted, but as late as 1882 was referred to by an eminent critic as "a theory which for simplicity and grandeur strikes every reader with astonishment. . . . No more admirable example of scientific method was ever given to the world." Darwin's exposition of his theory was certainly admirable, but it is going too far to say that a theory, from which the essential element of independent confirmation was lacking, is as admirable an example of scientific method as the world has seen.

Unwarranted Loss of Faith in Darwin's Theory.—Naturally enough, when another possible theory was put forward, a critic, who had no independent and crucial test in mind by which his belief in an earlier theory was compelled, lost his confidence in it, even though the later one had only the same insufficient recommendation of explaining what it was made to explain; for it was the same critic who, only a year after commending Darwin's theory of subsidence in the glowing terms just quoted, abandoned it and became the avowed champion of the theory of outgrowing reefs on still-standing islands. He may even then have

felt the keen regret expressed twenty years later "that this brilliant generalization of the great naturalist [Darwin] has been deprived of the wide application which for many years we attributed to it," for he wrote:

In face of the evidence which has now been accumulated, I can no longer regard the . . . theory [of subsidence] as generally applicable. . . . No satisfactory proofs of a general subsidence have been obtained from the region of coral reefs, except from the structure of the reefs themselves, and this is an inference only, which is now disputed. From the nature of the case, indeed, traces of subsidence can hardly be expected.

True, the fact that the depth of certain barrier-reef lagoons had been found greater than 20 or 25 fathoms, the limiting depth for the growth of reef-building corals, was taken to indicate subsidence for those particular reefs, but not for other barrier reefs within which the lagoons were shallower.

Yet it is precisely a general proof of subsidence, at once simple and convincing, that had been independently discovered and published by an earlier and responsible investigator thirty years before, and that was completely overlooked by those who accepted the newer theories; namely, the occurrence of embayments in the central islands of barrier reefs, by which Dana had not merely given new support to, but had provided much-needed confirmation for Darwin's theory; and the most curious thing about the matter is that the eminent geologist, who, after he had abandoned Darwin's theory, championed the still-stand theory in the sentences just quoted, had himself, in an admirable book written nearly twenty years earlier, explicitly recognized the origin of embayments by submergence; for he then said:

The sea lochs of the west coast [of Scotland] are thus not cut out by the waves, but old glens that have been submerged beneath the sea.

This is just as true for the numerous bays of the antipodal island of New Caledonia with its great barrier reefs as for the sea-lochs of Old Caledonia. In view of all this one must wish that the above-quoted champion of good work in all branches of geology would apply the elementary physiographic principle of shoreline development, not only to the drowned glens of Scotland, but also to the embayments of the reef-encircled Pacific islands where it is so clearly pertinent, and thereupon modify his conclusion that the theory of subsidence is no longer generally applicable in the explanation of coral reefs; for we may surely say of him what he said of an earlier student: The example of Darwin's own candor and overmastering love of truth remains to assure us that no one would have welcomed fresh discoveries [or, as we may interpolate, the resurrection of old discoveries] more heartily than he, even should they lead to the setting aside of his own work.

When the history of natural science is written, it will, I believe, come to be regarded as a curious commentary on the scientific methods of the nineteenth century, that choice among the various hypotheses invented for the explanation of coral reefs was guided so largely by personal habits of thought rather than by logical demonstration; for clearly enough the really successful one among all the proposed hypotheses can be detected only by its ability to survive a crucial test; that is, by its capacity to explain certain essential facts not in mind when it was invented and not explicable by any other hypothesis. A still more curious comment will be pronounced on the coral-reef chapter of scientific history, when it is learned that, as has been shown, a crucial test of the most admirably simple and convincing kind had been, as far as barrier reefs are concerned, discovered and announced a very few years after the publication of Darwin's theory of subsidence, but that it remained unnoticed for years thereafter. It never came to the attention of the author of the subsidence theory himself, perhaps because, as he wrote, "geologists do not read each other's books"; and it seems to have been altogether unknown to the inventors of the later alternative theories, who, had they been better informed, would have at once perceived that their inventions were incompetent.

Dana's Confirmation of Darwin's Theory.—From what has now been said, the nature of Dana's confirmation of Darwin's theory must be clear. The only obscure matter is: why was the clear confirmation so generally overlooked? Dana wrote in his report on the Geology of the United States Exploring Expedition, published in 1849:

The very features of the land [of barrier-reef islands], the deep indentations, are sufficient evidence of subsidence to one who has studied the character of the Pacific islands.

Farther on in the same volume, under the general heading, "Evidence of Subsidence," and the special heading, "Deep Bay-indentations in Coasts as the Terminations of Valleys," he stated the case more fully as follows:

In the remarks upon the valleys of the Pacific islands, it has been shown that they were in general formed by the waters of the land, unaided by the sea; that the sea tends only to level off the coast, or give it an even outline. When therefore we find the several valleys continued on beneath the sea, and their enclosing ridges standing out in long narrow points, there is reason to expect that the island has subsided after the formation of the valleys. For such an island as Tahiti could not subside even a few scores of feet without changing the even outline into one of deep coves or bays, the ridges projecting out to sea on every side. . . . The absence of such coves, on the contrary, is evidence that any subsidence which has taken place has been comparatively small in amount.

This explanation has been abundantly confirmed by later investigations; the principles that it involves are to-day everywhere accepted as

fundamental in the study of shorelines. The submergence of a mountainous coast must necessarily produce an embayed shoreline, with many out-stretching points of the land separating as many in-reaching arms of the sea. Bays thus produced are often called drowned valleys, in view of their origin. They are beautifully exemplified in many parts of the world far outside of the coral zone, as in the accompanying view of the Bay of Islands in northern New Zealand, Fig. 16. Simple as



FIG. 16. PART OF THE BAY OF ISLANDS, a half-submerged district in northern New Zealand.

the explanation of embayed shorelines by submergence is, it was first recognized by Dana in 1839 when he was on a mountain peak in Tahiti; he was indeed the first man in the whole world to perceive that valleys, half drowned by submergence, must form bays; and conversely that bays, which are continued downward from the non-drowned upper part of valleys, demonstrate submergence. But it was not alone that Dana gave this simple explanation of embayed coasts; he demonstrated further that embayments can not be the work of the sea, as seems to have been Darwin's idea, for Dana saw that the sea, unhindered by coral reefs in its attack upon a land margin, tends to simplify an indented coast line by cutting back its promontories, so that the complexity of outline seen in an alternation of lobate promontories and branching bays, interlocking with one another in intricate fashion when initiated by sub-

sidence, would be changed to a less irregularity of outline as the land heads were cut back in retreating cliffs, and the bay heads were filled up with advancing deltas; and that there would eventually be developed a marked simplicity of outline when the cliffs were cut farther back than the initial heads of the bays. Dana had good ground for his ex-

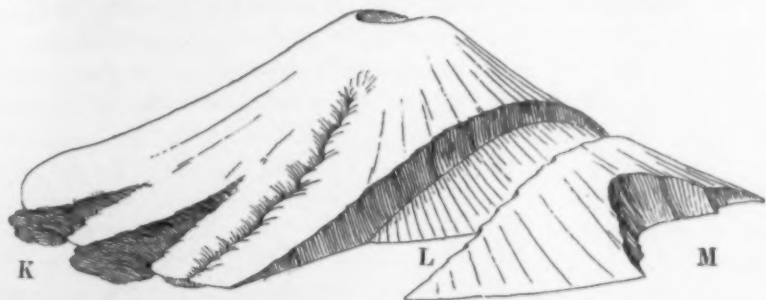


FIG. 17. DIAGRAM OF EMBAYMENTS AS IMAGINED ON A NON-SUBSIDED VOLCANIC ISLAND; *K*, between two advancing lava flows; *L*, in a transverse down-faulted trough; *M*, in a landslide cavity.

planation, for he was convinced that the valleys of the land, be they the short radial valleys such as he saw on the island of Tahiti, or the great complex of valleys such as he observed in the Blue Mountain plateau of Australia, are the product of subaerial erosion which works only above sea-level; it was for this good reason he concluded that a valley which is prolonged in a bay necessarily indicates submergence. This point is evidently important; for if a bay occupy a reentrant between two salient lava flows, as at *K*, Fig. 17, such as occur on the Fiji island of Taviuni, where recent volcanic action has taken place; or if a bay occupy part of a down-faulted trough or bight in a volcanic cone, as at *L* or *M*, such as perhaps occurs in the Fiji island of Moala; or if a bay occupy a large caldera, like that of Totoya, already mentioned,



FIG. 18. DIAGRAM OF PART OF THE SAME ISLAND AFTER SLIGHT DISSECTION AND PARTIAL SUBMERGENCE, showing reentrant embayments at valley mouths, *N*, *P*; and around the ravine sides of a down-faulted trough, *O*, and of a landslide cavity *Q*.

no subsidence would be thereby proved, inasmuch as these peculiar and easily recognizable forms can be produced by volcanic action either at or below or above sea-level: yet if the sides of an embayed bight *Q*, or trough *O*, are ravined, as in Fig. 18, and each ravine descends to a cove

in the shoreline of embayment, the side coves prove submergence after the down-faulting and erosion, even if the embayment of the down-faulted space does not; and such is the case in Moala: likewise, small embayments in a dissected caldera wall prove submergence, and such is the case in the ring-island of Totoya.

The Embayments of Barrier-Reef Islands.—But to return to our coral reefs. If it be true on general principles that the embayments of a dissected central island demonstrate that submergence took place while the encircling barrier reef grew upward, is it also true that the central

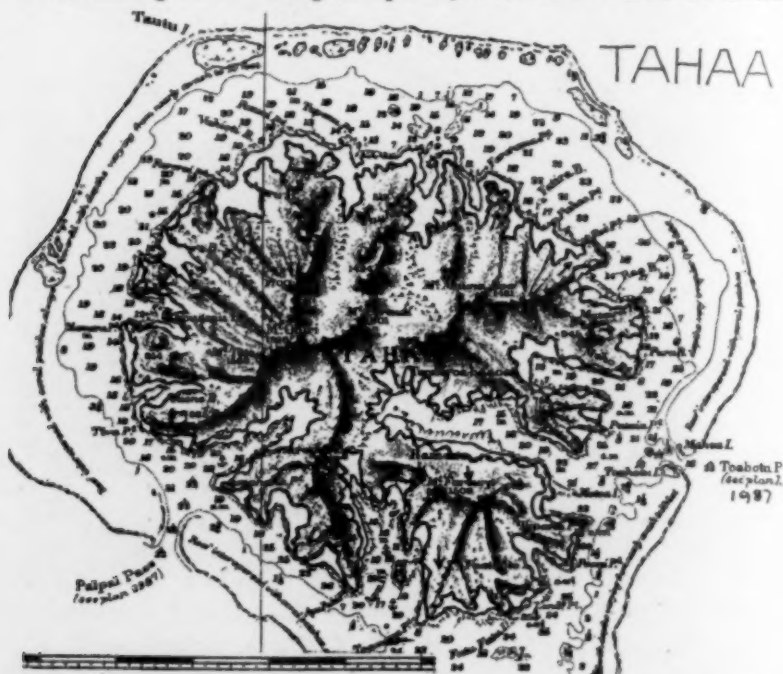


FIG. 19. BRITISH ADMIRALTY CHART OF TAHAA, SOCIETY ISLANDS. The outermost belt, with curved lines of fine print, is the barrier-reef flat; the lagoon is dotted with soundings in fathoms; a narrow fringing reef follows most of the present shore line; delta plains are blank, between the present shore line and the more sinuous original shore line (added in a heavy line) caused by submergence of the maturely dissected volcanic cone.

islands within barrier reefs are so generally embayed as thereby to establish, for barrier reefs at least, the truth of the subsidence theory? Yes, abundantly so; and not only are they elaborately embayed, but their embayment has long been represented on charts and stated in descriptions. Ninety years ago the same two missionaries who first suggested that coral reefs might be formed on wave-cut platforms, described the island of Tahaa, Fig. 19, in the Society group as distinguished "by the number, breadth and commodiousness of its harbors, with which the

whole coast is indented, some running quite into the heart of the country"; thus its outline is made so irregular that the natives compare it to a cuttle-fish, "the projecting headlands and intrusive creeks resembling the many tails or tentaculæ" of that animal. I went around the lagoon of Tahaa in a small motor boat, passing all its spur-end points and entering some of its larger bays, taking time to note the form of the spur-ends where they are cut off in low cliffs, and to sketch the inner border of the bay-head delta plains, in order to reconstruct the intricate salients and embayments that its shores would possess if the spurs had not been a little cut back, and if the deltas had not been built forward. The result is shown by the innermost and strongest black line of Fig. 19—the outermost line is the barrier reef—and it appears to me to be a result of a very striking nature. The small arrows on the spurs represent the dip of lava flows and ash-beds: their radial arrangements shows that the island represents a single volcanic cone, elaborately dissected and partly submerged. Evidently enough the bays would be much longer and more branching than now, if the deltas were removed; and as evidently the spur-ends would not be much longer than now if their original points were restored; but most evident of all, the outline thus reconstructed can be explained in no other way than by the submergence of an elaborately dissected volcano.

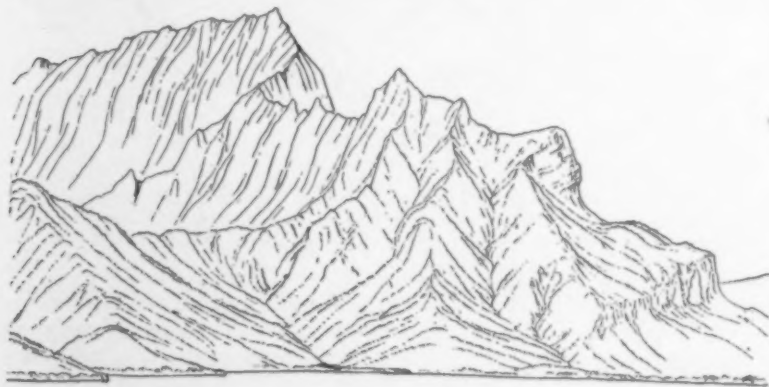


FIG. 20. SKETCH OF PART OF THE DEEPLY DISSECTED VOLCANIC MASS OF RAIATEA, SOCIETY ISLANDS. The embayment of the shore line, diminished by deltas, is not clearly shown because of foreshortening. Fig. 5 is a bay in the same island.

Let it not be supposed that Tahaa is of exceptional pattern. The neighboring islands of Raiatea, Fig. 20, was instanced by Darwin seventy years ago as possessing "those deep arms of the sea . . . which penetrate nearly to the heart of some encircled islands." I gave two days to the leisurely circuit of its lagoon. How wonderfully its original shape is transformed! How deep are the valleys between the sharp-crested

ridges! How gently the spurs slope down, hardly nipped at their ends, into the enclosed lagoon! Again, the Fiji islands make one of the groups in which Dana found many embayed islands to support Darwin's theory, yet that group has been said by some observers to occupy an area not of subsidence but of elevation, because elevated reefs occur on some of the islands. Such a statement is geologically altogether inconclusive; for the absence of elevated reefs on many members of the Fiji group shows that they have not suffered elevation. I saw eighteen of the Fiji islands on my voyage, and sixteen of these had embayed shorelines; the other two showed elevated reefs, as yet little dissected and hence lately elevated. A willing witness to subsidence in Fiji is the little island of Ono, Fig. 21, of mountainous form and irregular outline. A more

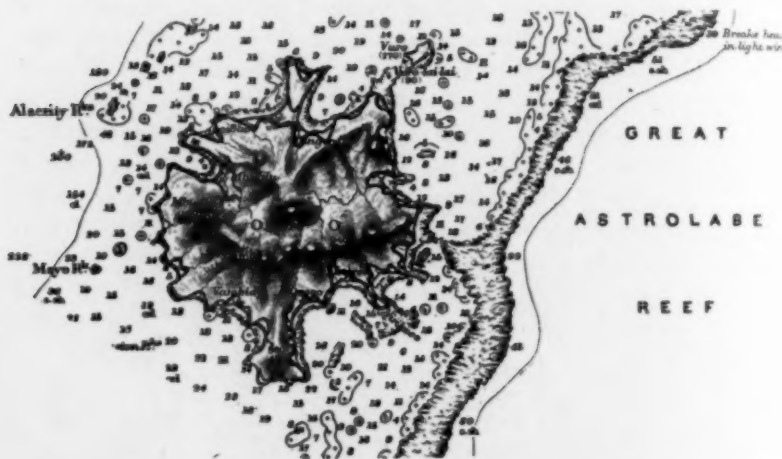


FIG. 21. BRITISH ADMIRALTY CHART OF THE EMBAYED ISLAND OF ONO IN THE GREAT ASTROLABE REEF, FIJI. The shore line of submergence is added in a heavy line. The larger island of Kandavu, Fig. 23, lies next southwest.

striking example is the larger island of Ka-ndá-vu, Fig. 22, next southwest of Ono; there the mountains are higher and the embayments are more pronounced; they indicate a recent subsidence of at least 600 or or 800 feet. When this is taken in connection with the elevated reefs of Fiji, some of which have been recently uplifted from 600 to 1,000 feet, a gentle warping of the ocean bottom is indicated; but that is not a surprising matter.

The Surprising Case of Ka-ndá-vu.—Indeed, the only surprising thing in association with the beautiful island of Ka-ndá-vu is, not the embayments of its shoreline, not the strong subsidence to which the embayments testify, but the statement regarding the island made by the chief advocate of the still-stand theory of outgrowing reefs: he wrote, several years after his visit to this island:

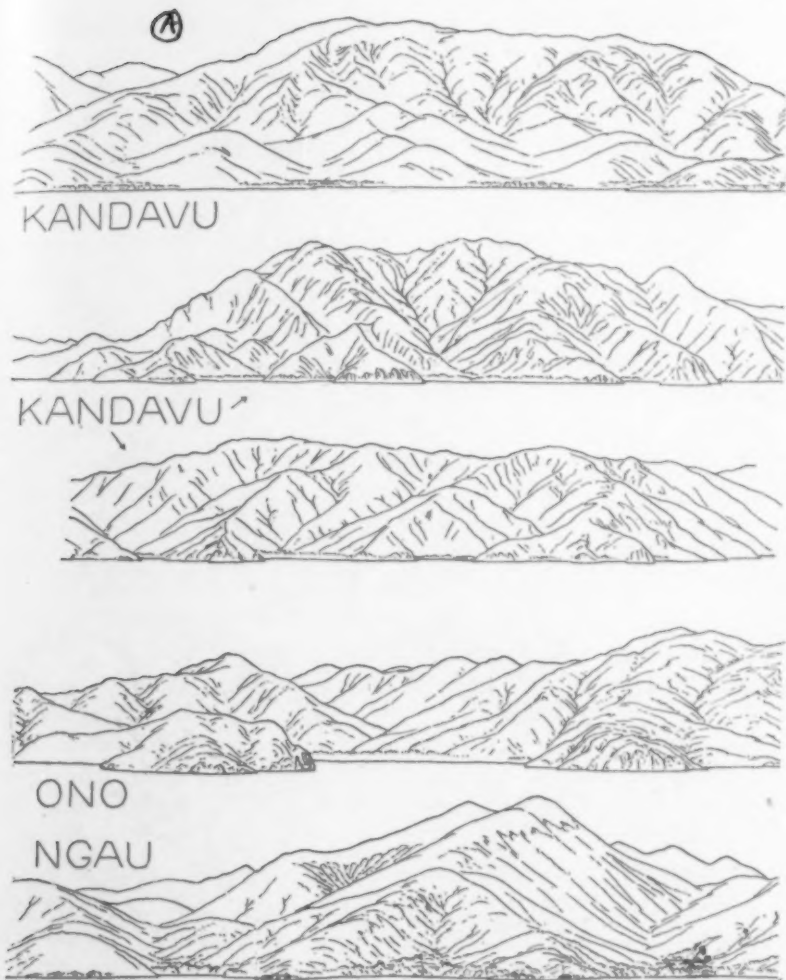


FIG. 22. SKETCHES OF KANDAVU, ONO, AND NGAU ISLANDS, FIJI, showing maturely dissected volcanic masses, with embayed shore lines due to submergence; the bay heads are occupied by deltas; some of the land heads are cliffed more than usual.

It was here that, not being able to apply Mr. Darwin's theory in explanation of the phenomena of the Kandavu reefs, I commenced to doubt it altogether. . . . The more observations accumulate the more does it seem to me probable that there never was a barrier reef or atoll formed after the manner required by Mr. Darwin's theory.

That is truly astonishing, indeed astounding! On reading it in presence of a detailed map of Ka-ndá-vu, Fig. 23, or still better in presence of the island itself, it will be understood more fully than before why the still-stand theory of coral reefs must, in so far as barrier reefs

are concerned, be regarded as a scientific blunder and its publication a bar to progress; for if one island had to be selected from all the islands of the Pacific as decisively favoring Darwin's theory, that island might well be Ka-ndá-vu. Yet hardly less unwarranted than the above quotation is the assertion by the same author that the still-stand hypothesis is in harmony with Dana's views of "the great antiquity and permanence of the great ocean basins"; for if there was any one man who believed that the bed of the ocean basins has not always stood still, but has sometimes subsided, that man was Dana.

In view of all this, it is inevitable that any hypothesis which postulates a fixed relation between the island foundations of coral reefs and the level of the surrounding ocean must be rejected. It may seem overbold thus on the ground of physiographic evidence summarily to set aside certain hypotheses that have been accepted by able investigators; and so indeed it would be had those investigators recognized the occurrence of embayed central islands, and had thereupon said: "Truly these embayments appear at first sight to be drowned valleys, but further study shows them to be of quite different origin, independent of subsidence"; but unfortunately they said nothing of the kind; they took no account of embayments at all. It is therefore well warranted to say, in view of the widespread occurrence of embayed central islands, that the postulate of a fixed relation of island mass to ocean surface is inadmissible. Theories of coral reefs and theories of ocean basins must include the possibility of a mobile ocean floor that carries oceanic islands up or down as it rises or subsides, or of a variable ocean surface that, as it subsides or rises, allows the emergence or submergence of still-standing islands.

The Evidence of Elevated Reefs.—We have thus far considered chiefly barrier reefs at sea-level. Let us now ask what testimony elevated reefs offer, for elevated reefs were specified on an earlier page as competent and communicative witnesses, whose testimony must be heard. But in order to appreciate the value of this testimony, let it be clearly understood that the still-stand theory requires elevated reefs to rest conformably on non-eroded volcanic slopes, because according to this theory, reefs must lie on a slope that has never subsided from a higher stand in which it might have suffered erosion; while the subsidence theory as definitely requires elevated reefs to rest unconformably on a slope that was eroded before it subsided.

An elevated reef, standing 20 or 25 feet above sea-level, has long been known to form a plain of variable width on the border of the Hawaiian island of Oahu, especially along its southern and western sides. The conditions of its origin have been much discussed. That it was formed during or after a time of submergence is clearly proved by

the following considerations: Oahu consists of the remains of two great volcanoes, an older and more dissected cone forming the smaller, western part of the island, and a younger and less dissected cone forming the the larger eastern part. Some of the valleys in the older western mass,



FIG. 24. A LAVA-BED SPUR BETWEEN TWO BROAD VALLEYS OF THE WEST COAST OF OAHU, HAWAII. The valley floors are entered by the limestones of the elevated reef which forms the coast plain.

Fig. 24, are one or two miles in width at the shoreline, and are enclosed by high, narrow, steep-sided spurs, on the flanks of which gently inclined lava beds outcrop in great number. The original floor of the valleys is not now visible, because each valley is occupied, in its shoreward part at least, by the lagoon-limestone plain of the elevated reef: the floor of volcanic rock must be, as well as one can judge by the slope of the valley-side spurs, hundreds of feet below the limestone plain; and this inference is confirmed by the depth of several artesian wells in limestone or non-volcanic beds. Hence the island must have stood hundreds of feet higher than now when the valleys were eroded, and must afterwards have subsided hundreds of feet in order to allow the lagoon limestones associated with the elevated reef to be deposited in the valleys. Since then, a moderate elevation with resulting erosion has taken place; and afterwards a still more moderate depression, for on the south side of the island the branching bays of Pearl harbor are nothing more or less than valleys eroded in the elevated reef plain and then drowned. The present sea-level reef of Oahu was formed in association with the depression that formed Pearl harbor.

Elevated reefs are found on many islands in the larger archipelagoes of the western Pacific. In the Philippines the island of Cebu is

terraced with reef limestones which rest unconformably on an eroded foundation of older rocks; and in such a case, as well as in Hawaii, the foundation mass must formerly have stood at least as high as now in order to suffer erosion; it must then have been submerged to the level of the highest limestone terrace at least; and it must finally have been uplifted to its present altitude. It is of course possible that the terracing reefs may have been formed during pauses in a slow emergence following a rapid submergence; but it is also possible that they were formed during pauses in a slow submergence followed by a rapid emergence; and it is again possible that some terraces were formed during pauses in submergence, and others during pauses in emergence. Nothing less than close study of the terracing structures will suffice to determine which of these possibilities corresponds to the actual occurrences of past time; but while we are waiting for such study, it is fair to quote this case as demanding submergence as a factor in the formation of the reefs in question, and as thereby warranting the postulate of submergence in other cases. Many other examples of unconformable elevated reefs might be cited: they all testify as unequivocally to the submergence of the eroded reef foundation before the reefs were formed or while they were forming, as to the emergence of the compound mass after the reefs were formed.

Which Theory is Best?—In view of the various sea-level and elevated reefs in situations so significant as those now mentioned, can any one who carefully deduces the consequences of the three hypotheses thus far presented, hesitate for a moment in making his choice among them? In the case of sea-level barrier reefs, where are the confluent deltas, projecting outside of a non-embayed initial shoreline, as demanded by the hypothesis of outgrowing sea-level reefs on still-standing islands? Where are the cliffs around a non-embayed shoreline, as demanded by the theory of veneering reefs on wave-cut platforms? And where are not the re-entrant embayments, with small deltas at their heads, as demanded by the hypothesis of upgrowing barrier reefs on subsiding foundations! In the case of elevated reefs, where are the unworn volcanic slopes beneath the steeply inclined talus of coral waste, as required by the theory of outgrowing reefs; or the truncated platforms beneath a coral growth of small thickness, as required by the theory of veneering reefs? And where are not the unconformable contacts of reef limestones upon an eroded foundation slope, as required by the subsidence theory!

The Origin of Atolls.—The confirmation provided for Darwin's theory by Dana's principle of shoreline development is as admirable and abundant for sea-level barrier reefs as is that provided by the unconformable contact of reef-mass and foundation for elevated reefs: but let it be explicitly noted that neither of these confirmations applies directly to sea-level atolls. Those inscrutable islands stand alone in the sea,

without witnesses to reveal their origin. They have been described as monuments over drowned volcanoes; they are monuments truly enough, and it has lately been shown that the Bermuda reefs have a volcanic mass beneath them; but no direct proof has been found that any sea-level atoll in the Pacific is built upon a volcanic foundation, much less that the foundation has subsided. The deep boring on the atoll of Funafuti in the Ellice group has led different students to different conclusions, though it seems to me that the evidence for subsidence is strong: unhappily the boring reached no volcanic rock. Nevertheless, it is probable that the atolls of the Pacific have subsiding volcanic foundations for the following reasons. Atolls sometimes occur in association with barrier reefs, as in the Fiji, New Hebrides and Society groups; and in such cases the subsidence of the volcanic islands proved for the barrier reefs may be very reasonably extended to the neighboring atolls. Sea-level atolls are in all cases exactly like barrier reefs, but for the absence of a central island; the process which has produced a barrier reef on a subsiding volcano must, if continued, change it into an atoll; and it would truly be singular if this process, so far advanced in some barrier reefs that their central islands occupy a very small fraction of their lagoon,



FIG. 25. CROSS SECTION OF THE ELEVATED ATOLL OF MARÉ, LOYALTY ISLANDS, showing the small knob of volcanic rock that rises in its lagoon plain to a less height than its reef rim.

had never continued a little farther; Maré, Fig. 25, the southeasternmost of the Loyalty islands, is a recently uplifted atoll, about twenty miles in diameter, and over 200 feet above sea-level; it has a low knob of eroded volcanic rock near the center of the limestone plain that represents the former lagoon, but the summit of the knob is lower than the reef-rim that encloses the plain, and hence the volcanic summit was below sea-level before uplift occurred. No uplifted atolls have been found to possess the particular structures characteristic of atoll formation by other processes than upgrowth during subsidence. On the other hand, the extensive oceanic subsidence demanded by the occurrence of atoll groups has been objected to as inconsistent with what is known of the origin of ocean basins; but so little is known of their origin that this objection has little force; the theory of ocean basins must accommodate itself to the subsidence that is demonstrated for barrier reefs and made highly probable for atolls.

Atolls Formed by Up- and Out-growth.—Let us now turn aside from the theory of subsidence and consider briefly another theory for the formation of atolls, proposed by the oceanographer who advocated the

still-stand theory of barrier reefs. Let *VVV*, Fig. 26, be a submarine mountain, presumably a volcano, the summit of which lies below the limiting depth of 20 or 25 fathoms, at which reef-building corals can grow. The frail calcareous shells of innumerable small pelagic animals, floating in the shallower waters, fall to the ocean bottom when the animals die, like "an organic rain"; and, in so far as they fall on the mountain, they aid the organisms living there to build it up, *QQ*; and thus eventually a submarine bank is formed near enough to the surface

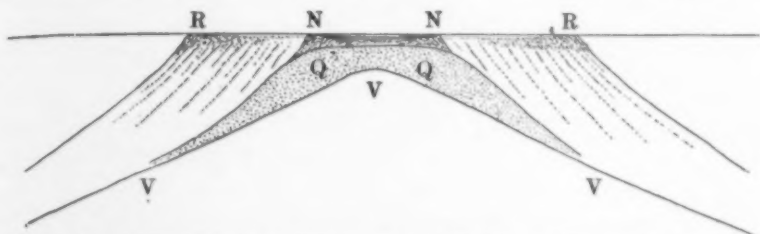


FIG. 26. CROSS SECTION TO ILLUSTRATE THE THEORY OF UP- AND OUT-GROWING REEFS: a submarine volcanic summit *V*, is built up with pelagic deposits, *Q*, and crowned with a reef, *N*, which has been enlarged by out-growth, *R*.

for corals, *NN*, to be established upon it. Then the corals grow outward on their own talus and form an enlarged atoll reef, *RR*, while the older part of the reef is dissolved out to form the lagoon. Such is the hypothesis for the production of atolls by up- and out-growth without subsidence. It is easily conceivable, but no one has yet shown that it represents any actual occurrence. Soundings have truly enough discovered organic deposits on submarine summits, but it does not seem probable that the fine calcareous deposits of the "organic rain" could remain on a summit when it reached depths less than 40 or 30 fathoms; the heavy waves of the ocean would sweep the deposits off into deeper water, and upbuilding would have to be continued by heavier forms of local growth. But it is not known that submarine summits stand still and suffer a capping of organic deposits to grow upwards nearly to the sea surface. So far as islands which rise above sea-level are concerned, their heads are as uneasy as if they wore a crown; emerged summits repeatedly suffer uplift or depression as well as still-stand pauses: it is therefore probable that submarine summits are similarly uplifted or depressed, for uplift and depression of super- or submarine volcanic masses do not result from changes within the masses themselves, but from movements in the suboceanic earth crust on which they stand. If the submarine summits are depressed, they could hardly be at the same time built up to the surface by the slow process of "organic rain"; if elevated, it is certainly singular that they all stop rising in the regions of true atolls before they emerge. Hence this theory is encompassed with improbabilities.

Furthermore, no elevated atoll has been described as showing the structures demanded by this theory; hence the theory stands merely as a possibility without direct support. But an island in the Solomon group has been figured as possessing a volcanic core, *V*, Fig. 27, partly



FIG. 27. REPRODUCTION OF A CROSS SECTION OF ONE OF THE SOLOMON ISLANDS, much exaggerated vertically.

covered by pelagic deposits, *LL*, other than coral, and these in turn are surrounded by an uplifted coral-reef terrace, *RR*, not so high as the pelagic deposits: and this composite structure has been taken as confirming the up- and out-growth hypothesis just stated. The confirmation is not convincing for several reasons. First, the volcanic summit, *V*, has a greater altitude than the pelagic deposits, *L*, and this would seem to show that the summit had been built up above sea-level before the "organic rain" fell on its flanks. Second, the pelagic deposits, *L*, have a greater altitude than the coral reef, *R*, and this shows that uplift of the cloaked volcano preceded as well as followed reef formation. Third, the threefold structure is vertically exaggerated in Fig. 27; it might be better represented by *VLR*, Fig. 28. Fourth, the contacts of the pelagic deposits with the volcanic cone, and of the reef limestones



FIG. 28. THE SAME, REDRAWN WITH LESS VERTICAL EXAGGERATION, showing on the left a volcanic slope, *V*, conformably overlaid with pelagic deposits, *L*, and these conformably built upon by a reef, *R*; the threefold mass having been twice elevated. On the right, the three structures, *U*, *J*, *S*, are drawn with unconformable contacts, indicating two depressions and two uplifts.

with the pelagic deposits remain undescribed: perhaps, instead of representing an unbroken succession of submarine deposits, they may be separated by surfaces of erosion, and thus represent discontinuous deposits, as *UJS*; that is, the volcano may have stood above sea-level and suffered erosion for a time, before rapid subsidence drowned it for the receipt of the unconformable pelagic cover; uplift and erosion of the composite mass may then have taken place before renewed subsidence permitted the formation of the reef; not till then may have come the present uplift of the threefold mass. Changes of this kind may seem cumbrous. If so, let me commend the attentive study of the following example from the new Hebrides.

Uplifted Reefs in the New Hebrides.—On the northwest side of the

island of Efate in the New Hebrides a series of well-bedded, nearly horizontal tufts, *NN*, Fig. 29, described as containing *Globigerina* and other pelagic foraminifera, is deeply eroded in valley-side slopes of over 800 feet, which descend to the drowned-valley embayment of Havannah harbor; and the slopes are terraced by a number of elevated fringing reefs, *TTT*, which contain abundant and well-preserved fossil corals, and which lie unconformably on the eroded slope of the tuff beds. If

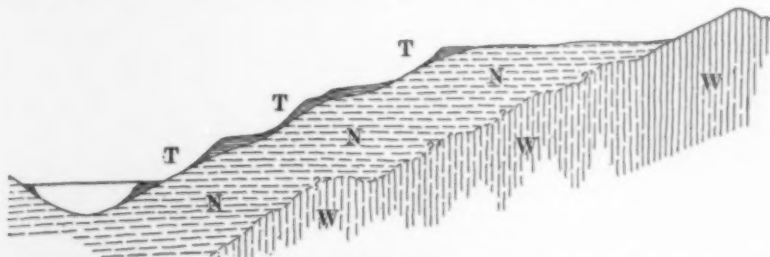


FIG. 29. CROSS SECTION TO ILLUSTRATE THE UNCONFORMABLE CONTACT OF THE ELEVATED FRINGING REEFS OF EFATE, in the New Hebrides group, on an eroded mass of horizontal marine strata, *NN*; the nature of the contact of the marine strata on their volcanic foundation, *WW*, is not known.

this is interpreted in accordance with well-established geological principles, we must conclude that the island stood several hundred feet lower than now when the foraminiferal tufts were deposited: that it was then raised higher than now for the erosion of the drowned valley of Havannah harbor; that it then subsided low enough for corals to form fringing reefs up to the very top of the eroded slope; and that it was finally raised at least to its present altitude, leaving the valley bottom drowned. Whether the fringing-reef terraces were formed during the last uplift or during the preceding subsidence is not easy to determine; their formation during uplift has been announced by a young Australian observer, but he did not recognize that the truncation of the tufts demanded previous elevation, erosion and depression. In company with Mr. E. C. Andrews of Sydney, New South Wales, I reviewed the section with the earlier observer's report in hand; and the formation of the reefs during intermittent subsidence followed by rapid uplift, rather than during intermittent uplift preceded by rapid subsidence, seemed an explanation well worth considering. Whether the tufts of Efate lie on an eroded or a non-eroded volcanic foundation, *WW*, I can not say; but in Viti Levu, the largest island of the Fiji group, similar marine tufts seemed to lie, at the only point of near-contact that I reached, unconformably on an eroded volcanic slope; if the same relation occurred on Efate, a strong submergence must have taken place after the initial volcano was built up and eroded, and before the tufts were laid down on its eroded flanks. The absence of details of this kind from the

description of the island in the Solomon group (Fig. 27) makes it for the present an incompetent witness. The upshot of all this is, that the up- and out-growth hypothesis, which explains atolls as the crowns of pelagic deposits built up on submarine foundations, is as yet without support by well-observed facts; and hence that Darwin's theory of subsidence provides a simpler and better supported explanation of atolls than any theory yet invented.

Objections to the Theory of Subsidence.—Are we then to understand that no objections can be raised against the theory of subsidence? Hardly that, for many objections deserving consideration have been urged. First is the objection that an extravagantly large volume of limestone is needed to build atolls on the subsidence plan. This is perfectly true, but it is also true that the outgrowth plan is hardly less extravagant. Extravagance seems sometimes to be the order of nature, as in building up voluminous volcanic cones by eruption through the earth's crust beneath the ocean; some of the cones, if measured from the ocean bottom, are of staggeringly large dimensions. But the best answer to this objection is found in two of the Loyalty islands, next northeast of New Caledonia; they are uplifted atolls 20 or 30 miles in diameter and now standing 200 or 300 feet above sea-level, without a sign of any rock but limestone around their rim, though one of them (Maré) has, as above mentioned, a small knob of volcanic rock in the center of its uplifted lagoon-plain; if the volcanic mass of which the knob is the summit be given a slope such as is commonly observed in volcanic islands of the Fiji group, the thickness of the limestones at the margin of the island must be at least 5,000 or 6,000 feet. As far as this goes, it indicates that heavy limestone masses really do occur beneath the crown of an atoll reef.

A second objection to the theory of subsidence is based on the absence of heavy coral-reef limestones from ancient geological formations. To this it may be answered that, while parts of continents have in the past presumably been transformed by depression into deep ocean floors, deep ocean floors do not seem to have been transformed by elevation into continents; or if they have been, the lofty overtopping atolls then uplifted must, as a rule, have been worn away, just as all lofty mountains and volcanoes of Paleozoic and Mesozoic times have been worn away. The roots of ancient mountains and volcanoes are found beneath less ancient geological formations, but not the summits. Similarly, it is only the base of ancient atolls that would commonly be preserved under less ancient geological formations, and not the tops. Another answer to this objection is that the heavy dolomites of the Tyrol do, by way of exception, represent ancient coral reefs, and thus show that ancient reefs are occasionally preserved.

A third objection to the theory of subsidence is, as above noted, the necessity of a great depression of the Pacific ocean floor in recent geological time over the immense area occupied by groups of barrier reefs and atolls. So great a depression is held by some to stand in contradiction to what is known of the dynamics of ocean basins; but in answer it may be urged that the evidence of strong ocean-bottom subsidence over large areas, as given by atolls, must be added to the little else that is known about the ocean floors before safe inferences can be drawn as to the amount of deformation which their basins have suffered. It may be briefly noted that the inferred contemporaneous lowering of ocean water and the consequent laying bare of all continental coasts, as a result of a great deepening of the Pacific atoll areas, is not necessary; for it may be assumed with much probability that adjacent parts of the Pacific floor suffered a roughly compensating elevation, as Darwin suggested, when the atoll areas subsided, and hence that contemporaneous changes of ocean level were relatively small.

A fourth objection to the theory of subsidence, urged by an eminent geologist, must be regarded as the most singular of all objections. It is as follows: "Upheaval has taken place in areas where barrier reefs and atolls are in vigorous growth. Such an association of upheaval with an assumed general subsidence requires, on the subsidence theory, a cumbersome and entirely hypothetical series of upward and downward movements," and hence is improbable and unacceptable. This pronouncement is, in view of its source, one of the most extraordinary that I have encountered in coral-reef literature. It tempts me to follow for geologists the example of the late William James, who divided philosophers into two categories, the tender-minded and the tough-minded. Let us divide geologists into the same two classes, and among the tender-minded place those who hesitate to accept a theory of coral reefs that involves repeated uplifts and depressions of the earth's crust because such terrestrial uneasiness is mentally distressing; and among the tough-minded, those who are perfectly ready to follow good evidence wherever it leads, even to the cumbersome series of upward and downward movements shown by elevated reefs in Fiji and by Efate in the New Hebrides. It is consoling to remember that James avowed himself to be one of the tough-minded pragmatical lot.

(To be continued)

ANNEXATION AND CONQUEST

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IN the minimum program of the Central Organization for the Study of a Durable Peace, the first article reads as follows:

No annexation or transfer of territory shall be made contrary to the interests and wishes of the population concerned. When possible, their consent shall be obtained by *plébiscite* or otherwise.

On this article I am asked by the executive committee of the Central Organization to present my comments.

Its essential features may be summed up in these words: "No right of conquest; no annexation by force." Its thesis is vigorously urged by Immanuel Kant in the second paragraph of the first section of "Perpetual Peace." Says Kant:

A state is not a possession or a patrimony like the soil on which it has its seat. It is a human society subject to the authority and disposition of none but itself. Since, like a stem, it has its own roots, to incorporate it as a graft into another state is to take away its existence as a moral purpose and to make of it a thing. This contradicts the idea of the original compact, without which no authority over a people can be conceived. Everybody knows into what danger, even in the most recent times, the supposed right of thus acquiring states has brought Europe. . . . This has been looked upon in part as a new kind of industry, a way of making oneself powerful through family connections without putting forth personal effort, in part also as a way of extending one's landed possessions. . . . Thus the subjects of the state are used and abused to be handled at will.

It can not be denied that the views above quoted conflict seriously with tradition, theory and practise in past European history. The curse of modern Europe is its burden of history. Every generation is filled with remembrance of the futile glory of past wars, with futile hatreds of the people against whom the wars were fought. The teachings of the schools furnish many of the standing incentives to war. Through these agencies the war-system has perverted and poisoned all lessons in history, in patriotism and even in religion. The way out is to start afresh. That this may be possible is one of the cheering lessons to be drawn from European history. For example, my friend and teacher, Andrew Dickson White,¹ reminds me that "the religious wars which had been going on for well over a thousand years were forever ended by the Treaty of Münster in a universal feeling of shame and dis-

¹ In a letter dated Cornell University, January 27, 1916.

gust." So we may hope that the present inexpressibly tragic confusion may end in the stable development and rational development of international law.

The article under discussion represents in spirit a great advance in international law. It stands for the right of small civilized nations to autonomy and integrity. It opposes the dismemberment of any nation, large or small. It removes certain standing incentives to war by eliminating supposed advantages of victory. To put this rule into operation at the end of the present war would add enormously to the stability of civilization.

In the following pages I shall briefly treat various details under five heads: (1) The Assumed Right of Conquest, (2) the Use of the *Plébiscite*, (3) Secession and Nationality, (4) Colonial Adjustments and finally (5) Conclusion.

I. THE ASSUMED RIGHT OF CONQUEST

The great argument against the right of conquest lies in its fundamental injustice. It furthermore interferes with the stability of society. The conquest of the whole or part of one civilized state by another involves an assault on the well-being of all. The conquered state at once encounters serious interference with its own manners and customs. It naturally tends to resent this interference, and soon its resentment becomes an intrusion into the established discipline of the victor. Both these conditions followed the annexation of Alsace-Lorraine, making this region, on the one hand, "the nightmare of Europe" (*le cauchemar de l'Europe*), and, on the other, the "wound in the side" (*la plaie dans les flancs*) of the great empire to which it was forcibly united. Whatever the motive of such annexation, it necessarily leads to dissatisfaction in the smaller group and disunion in the larger. Moreover, the precept that "Might makes Right" or its sophistical equivalents that "Might creates Need" and "Need creates Right," whether applied to men or to nations, is offensive to the moral sense of civilized humanity. For example, the nationality of Belgium must be absolutely maintained. Anything less than this would leave Europe wholly unstable. Serbia and Montenegro should also be restored.

An argument for annexation by force frequently advanced is this; that to guarantee future peace and prevent attack from outside a fringe of alien territory must also be secured. Dr. John Mez writes:

The creation of so-called buffer states may indeed from a military and strategic viewpoint serve those ends of securing the national boundary, but the experiment of securing peace by such conquest has been tried several times in history and proved a failure every time. Bismarck had intended merely to seize Alsace and the German-speaking parts of Lorraine, but military experts insisted that a portion of the French-speaking district should equally be taken for

strategic reasons and "in order to secure the peace." It was said: "The fortress of Metz is worth 100,000 soldiers in case of another war." Thus Bismarck was induced, almost against his will, to consent to the annexation of Metz and the region about it. Peace insurance by conquest is one of the greatest fallacies of history. It is distinctly and naturally *disadvantageous* to both victor and vanquished, and, instead of preserving the peace, it necessarily defeats that end, since out of it grows the inevitable desire for "wars of revenge" in the nations despoiled. Apart from this it is a gross injustice to the inhabitants of the conquered province itself. It is also immoral, creates a dangerous precedent which in some future day may be equally applied by other parties. Here is the main reason for protesting against the idea of conquest of territory, even if alleged to be made not for gain, but to make a country secure from attack or to ensure peace—a shallow phrase—used over and over again as an excuse for the crime of a large-scale robbery.

The system of "scientific frontiers" leaves a boundary marked by dissatisfaction and surrounded by suspicion and hate. A wise Alsatian once said to me: "The best boundary fortress is a contented people." (*"Die beste Grenzfestung ist ein zufriedenes Grenzvolk."*)

II. THE USE OF THE PLÉBISCITE

Rejecting then the principle of the use of force as a means of extending jurisdiction, we may consider some of the details involved.

First, as to the "interests and wishes" of the population concerned. These may not altogether coincide if by interest one means financial advantage. In general, the more cultured a body of people, the more will interest and wishes approach agreement. For with advanced people wishes rise to have an intellectual value and interests a moral value unknown to barbarous races. With barbarous races, the desire to be let alone outweighs most forms of economic interest, as these necessarily involve a degree of personal restraint or collective discipline.

How then shall we ascertain "interests and wishes" in a given case? Manifestly we cannot trust a victorious nation. Two methods remain, the one an international tribunal, the other a vote of the people themselves in the conquered district. As to the first, the results of international commissions or "concert of powers" have not been thus far encouraging, but the sources of failure lay in their partisan composition. In the Balkan crisis, most members of the concert, conventional diplomats, represented interests which hoped to gain by confusion, and the present war has its excuse if not its cause in the disorder resultant from the incongruous adjustments of Balkan affairs in the Treaties of London and of Bucharest.

On the other hand, a wise, impartial and non-partisan commission is possible if the several states will together set up a righteous standard. In a well-ordered continent just action may be expected from nations as well as from individuals or corporations. "Peace is the duration of law," that is, of justice.

The *plébiscite* or ballot is a device for ascertaining the will of the people. It is not clear that this can ever be safe and effective in determining the fate of any disputed district of Europe. The process can have no value unless voting rests on intelligence and the ballot is fully guarded, with a secret vote and the absence of all duress, intimidation or bribery. And as some form of duress is a regular accompaniment of the suffrage in many parts of Europe, we can hardly expect the stream to rise above its source. Even in the best-ordered districts a *plébiscite* as to national allegiance would be fraught with embarrassments. In case of any change in this regard public feeling would run high in both the states concerned, as well as in the strip of territory to which the *plébiscite* is applied. This condition would encourage intrigue, with manipulation of public opinion. The struggle for ascendancy would interest the rest of the world, and sympathies racial, political religious, would form a disturbing element far beyond the limits of the regions concerned. "I can imagine," says Professor Walter Rauschenbusch,² "a *plébiscite* turning into an active volcano. . . . This provision would operate as an almost insuperable check against any change. It would give the population no initiative, only a veto."

At once, in any plan for *plébiscite*, three problems arise: (1) How large shall be the voting units? (2) What rights shall the people have within the nation to which they may assume allegiance? (3) To what extent are the principles of toleration set forth in Article 2, democratic equality before the law, religious liberty and tolerance of language, to be guaranteed in the chosen relations? Allow me to discuss these problems at some length and by venturing on certain illustrations.

Before the war between Prussia and Denmark, Schleswig as a whole, being very largely occupied by German people, had the choice been offered, would doubtless have voted for transfer to Germany. But had smaller voting units been adopted, northern Schleswig or its city of Flensburg would certainly have elected to remain in Denmark, while the body of the province would have attached itself to Germany. Such a decision would not have necessarily been because northern Schleswig is Danish, a fact in itself of secondary importance. The determining factor might have been that, speaking Danish rather than German, the people were subject to minor persecutions on that account. Being assured of such tolerance as our Article 2 contemplates, they might have elected to remain in Germany, for presumably their financial interests would be better served within the German *Zollverein*. With fair play, old hatreds soon die out. It is not necessarily language or race which determines choice of allegiance. Partly it may be tradition, partly the feeling of equality before the law, and for the rest, mainly continuity of manners and customs.

² In a letter dated Rochester, February 9, 1916.

In Alsace-Lorraine, however, for example, the results of a *plébiscite*, if conducted before the present war, would have been determined by other questions than that of simple preference for France or Germany. The region inhabited by people of French blood would assuredly not have wished to detach itself from that where German blood predominates and where a German dialect is spoken by the peasant classes. A common experience had inspired in "Alsace-Lorrainers" a feeling of like nationality. Their first allegiance was to *Alsace-Lorraine*. Undoubtedly Alsace and Lorraine, of differing speech and origin, had been welded into one common experience. This fact is expressed in the doggerel verse,

*Français ne peux,
Prussien ne veux,
Alsacien suis.*

So the first choice of these people would have been to stand together, their next, local home rule in details of custom and language. This they had had under France, but not under Germany. Politically, the first preference of most would no doubt have been independence, an unfortified neutrality alongside of Switzerland, Luxembourg and Belgium. They would thus have formed a republic of free men, a bridge connecting the culture of France with that of Germany. As their business interests allied them to the rest of the Rhine valley, they might have been glad to remain in the German *Zollverein* if freed from linguistic and other restrictions. Failing in this, they might have chosen to be incorporated into the republic of Switzerland of which Mülhausen once formed an integral canton.

The former bond of Alsace-Lorraine to Germany rested on business relations and on the large influx of German manufacturing interests in Strassburg and Metz. Its persistent opposition was due largely to Germany's failure to grant full citizenship, leaving the people as "*Deutsche zweiter Klasse*" inhabiting "*Reichsland*" or Territory of the Empire. Resentment against this condition was stronger in German Alsace than in French Lorraine, partly, no doubt, because more French than Germans had emigrated from the land to escape Pangermanist influences. Matters of language became really important only through attempts to suppress the use of French.

It is not important to the unity of a great nation that all its people should speak the same language. Stability is assured by equality before the law and the recognition by all that under a common government their individual personal rights are assured. In the words of Albert Oeri of Basle,

A compatriot who thinks our thoughts is nearer to us than one who merely speaks our tongue.³

³ "Pour un Suisse un compatriote de langue différente est plus cher qu'un étranger de la même langue."

Most attempts to define nationalities by race lines are bound to fail. Language and race cross every border, sometimes producing inextricable mixtures of blood and tongues. Kinship in spirit is more vitally essential. The ideal of a unified nation with one race, one speech and one religion is a reactionary one regarded as necessary to an oriental despotism, but out of place in modern international Europe. To illustrate further, the complexities of the political problems sure to arise at the conclusion of the present war, I again make use of Alsace-Lorraine in illustration. If at the end of the war a *plébiscite* were to be offered to this district, the problem would be by no means simple. Several possible alternatives would present themselves, each having formerly had its special advocates. The provinces could (1) remain as at present, the people being still "*Deutsche zweiter Klasse*," living on "*Reichsland*," or territory of the empire; or (2) become part of the Grand Duchy of Baden; or (3) remain in Germany, but as one of the autonomous or self-governing states of the empire; or (4) become a free state or republic within the empire, comparable to the free cities of Hamburg, Bremen and Lübeck; or (5) become an independent nation like Switzerland, thus forming one of a series of buffer states between France and Germany, either (a) unfortified like Luxembourg, perhaps retaining the commercial advantages of the Imperial *Zollverein*, or (b) armed like Belgium and Switzerland, or (6) return to France in spite of the fact that in the centralized republic the district would as before be reduced to three departments or local jurisdictions (Haut-Rhin, Bas-Rhin, Moselle) instead of forming one united province of "*Elsass-Lothringen*," as at present. Or, as further alternatives, neither of them I believe acceptable to the inhabitants, the area might (7) be divided crosswise, separating Lorraine which is largely French, from Alsace, where the original stock was Germanic, or (8) divided lengthwise, returning the French-speaking communes on the Moselle or along the summits and west flank of the Vosges to France, retaining and leaving the rest of Alsace and of Lorraine in Germany. Either of these propositions would be regarded as mutilation for reasons I try later to make clear.

Finally in any discussion of this particular problem must be weighed the claim of France that a *plébiscite* at the present epoch would be unwise and unfair, as the will of the provinces for all time was indicated in the protest of the retiring Alsatian members of the French National Assembly in Bordeaux in 1871. The partial colonization of Strassburg and Metz with Germans should not affect, it is claimed, the status of the districts which, as aliens, they have entered.

I have chosen Alsace-Lorraine as an example of the difficulties of a *plébiscite* even in a highly civilized region. Before one could be under-

taken, the different alternatives should be clearly announced, as also the proper provision for the safeguarding of the rights of minorities. Respect for minority rights is one of the best tests of the enlightenment of a nation. While in political questions majorities rule within accepted or constitutional limits, the personal or social rights of the minority should not be abridged or taken away. The size of the voting unit hinges in some degree on this question. It must rest on wise political judgment. It would be possible to divide Schleswig satisfactorily, as the Danish or discontented portion is geographically a part of Jutland in Denmark. It would be unsatisfactory to dismember Alsace-Lorraine, Finland or Bohemia. A similar question has been bitterly argued in Ireland, first as to the autonomy of Ireland as a whole, and second, in case of division, as to the integrity of northern Ireland, the ancient Province of Ulster. But the exclusion of Ulster from Irish Home Rule would leave the same question of the rights of minorities. For of the nine counties of Ulster all but three, Down (Belfast), Antrim and perhaps Derry (Londonderry), would choose to be linked with the rest of Ireland. Throughout the island there are "Unionists" and "Nationalists," just as in Alsace-Lorraine there are "French-minded" and "German-minded" people ("*französisch-gesinnt*" und "*deutsch-gesinnt*") in every commune. Any decision of the majority should leave the rights of the minority intact.

III. SECESSION AND NATIONALISM

It is clear that no denial of the right of conquest could be made retroactive. To attempt this would throw Europe into confusion. With time, vested rights become entangled with vested wrongs, and any effort to correct the latter, suddenly and as a whole, would involve a general overturn of government. For this reason, the "right of secession" of any province or group of people can not be unconditionally admitted. It exists only in connection with the larger right of tolerance of race, religion and language. The world is concerned in all these problems, as an imperfect solution endangers the world's right to peace. But they can not be settled by a reversal through secession or a conquest of *revanche*. They can be finally adjusted only by a generous tolerance with the recognition of the rights of minorities on the part of the general government. Without such tolerance any conquered province "will remain a wound in the side" of a great nation, finally impairing its integrity.

To concede the right of secession by *plébiscite* would involve consideration of the variant claims of a dozen districts more or less discontented with their present lot. It will therefore be necessary to proceed "on the pragmatic principle of letting sleeping dogs lie," not raising more complications than are strictly necessary. Recent attempts to

reconstruct the map of Europe on the basis of nationalism have shown their own futility. Race and language, as I have already remarked, interlock in every quarter. In the Balkans, for example, every race has overflowed into all its neighbors, its migrated members having meanwhile acquired new languages and new customs.

In general, the grant of autonomy with home rule in intimate matters is a far more practicable solution than independence. But independence once secured is preferable to unwilling or undesired autonomy within a larger nation. In all these great affairs the burden of proof should lie against change in actual status unless conditions have become wholly intolerable. A compromise empire or coalition such as Austria-Hungary, for example, is preferable as an agent in civilization to the frank discord which would follow dismemberment. The disorder now existing among the independent states of the Balkans well illustrates this. Whether autonomy be a solution in any particular case or not must depend on the actual conditions. To grant independence to all more or less suppressed races, would involve Europe in the anarchy of the Middle Ages.

Nationality for example, has been more or less insistently demanded, by Ireland, Finland, Poland, Bohemia, Alsace-Lorraine, Ukraine, Slavonia, Bosnia, Macedonia, Armenia, Albania, Korea, India and the Philippines. The claims of these districts are of varying plausibility, and in some cases autonomy in a degree has been already granted. Others are in a more or less anarchistic state in anticipation of home rule. To grant autonomy with equality before the law, and especially equality of language, would solve many of these difficulties. And not many of the others could be adjusted by shifting the boundaries in the interest of nationality.

The districts severed from Bulgaria, or at least refused to her at the treaty of Bucharest, should have their relations reconsidered by some competent tribunal, any form of *plébiscite* being, in this connection, impossible. The wholesale suppression or ejection of a large percentage of the inhabitants of Macedonia, Thrace, Dobruja and Novibazar, has made final justice an impossibility. Upwards of a million peasants in the various Balkan countries were homeless refugees in the early part of 1914. The number of these has since been reduced, but only by death. For this region there is no way out, except through tolerance of language, race and religion, all this being comprehended in the phrase, "Equality before the Law." Beyond this their economic needs demand a common customs-union which shall abate the heavy tariff burdens laid on each other and on themselves.

Even within the boundaries of would-be nationalities there may exist great injustice. In Galicia the Poles, annexed against their will but still as landlords retaining a considerable degree of freedom, treat

with great harshness the agricultural population largely composed of Ruthenians or Little Russians. In Russia both Poles and Ruthenians (Ukrainians) find themselves more or less oppressed, while all parties join in the persecution of the Jews, and the Jews in turn find means for a certain degree of revenge.

In certain recognized states, for example the Ottoman Empire, which is merely an army of occupation holding a population of five times its own number, any considerable degree of self government or even ordinary tolerance would mean dissolution.⁴ If the Turks did not rule, the people would and they would insist on the "bearable life" not attained by any race under Turkish rule. It is claimed on good authority that recurrent massacres were absolutely necessary if Ottoman rule were to be maintained. Except through extremes of violence⁵ the "grim, raw races" of the Near East could not be held in check. A sovereignty maintained by such means is not a nation in any proper sense, and has no claim to recognition in a sisterhood of states.

IV. COLONIAL ADJUSTMENTS

Thus far in this discussion, I have considered only the problems of annexation in Europe. These concern relatively homogeneous populations, accustomed to a degree of self-government and to some process of voting. The colonial systems of the various nations offer an entirely different set of problems. In dealing with people wholly barbarous, there may at times arise a necessity requiring domination or even conquest on the part of a civilized state. President William Howard Taft has suggested that "while the rule of Article I. might be generally true, there might be exceptions in which the progress of the world would require a departure from the principle where the people are ignorant or depraved, or where they otherwise show their unfitness for self government by continued anarchy."⁶

That such exceptions may occur we must admit, although the "right of conquest" as applied to them is fraught with serious dangers. Such as may be allowed should be not a "right" but a "duty." The greed of exploitation is often a ruling motive in bringing law and order to feeble and discordant peoples. Decisions on questions of this sort ought ultimately to be more or less international. The purpose of occupation should be the general welfare, not merely the protection of exploiting interests.

⁴ "To concede absolute equality would be to commit suicide."

⁵ "In our reconstitution of the Ottoman empire administrative conformity must be absolute. Autonomy is treason. It means separation. Our Christian compatriots shall be Ottomanized citizens. We shall no longer be conquerors and slaves but a new nation of freemen." (Riza Bey, quoted by John Macdonald, "Turkey and the Eastern Question," 1913.)

⁶ In a letter dated New Haven, January, 1916.

The relations of the United States to the conditions in Mexico may be considered in this connection. They afford an illustration of the difficulties which beset a nation which is desirous of seeing order maintained in a disorderly neighbor, but wishes at the same time to avoid armed intervention, costly and dangerous, as likely to entail occupation and ultimately a most undesired annexation. Mexico was for three years in the hands of rival groups of bandits, with no certain prospect of any orderly adjustment of its affairs. The United States has thus far (February, 1916) refrained from intervention in the face of various provocations, such restraint seeming to be, in the opinion of most, the lesser of the two evils. Should military occupation ever be found necessary, it is understood that it should be undertaken only with the cooperative sanction of the leading states of South America, and with no intention of annexation of any part of the territory occupied.

An over-seas district controlled or affiliated for any purpose by a civilized nation has received the general name of "colony." In this sense a colony may range from a coaling-station to a continental dominion or commonwealth.

The civilized colonies which have risen to be independent nations, affiliated with but not controlled by the mother country, are all in the temperate zones, and nearly all are outgrowths from Great Britain. These are Canada, Australia, New Zealand and South Africa, and no present question of annexation or conquest concerns any of them.

The holdings which are chiefly serviceable as coaling-stations or as fortresses guarding channels of trade are also mainly British, and apparently none of them is directly concerned in the outcome of the present war, unless indeed, civilized nations should come to the agreement that all lanes of traffic be left unfortified. Such an arrangement is much to be desired in due time. It would involve dismantling the fortresses which now guard the Dardanelles, the Bosphorus, the straits of Gibraltar, Aden and Dover, as well as the defenses of the Suez, Panama and Kiel Canals. The more completely force can be separated from commerce, the better for civilization.

In general, most colonial dependencies are held as speculative properties, prospective sources of revenue, or else for the purpose of imperial glorification, which Norman Angell calls "The Mirage of the Map." Most of the great holdings in Asia and Africa come under this last head, yielding no national revenue comparable to the expense of maintenance, and serving to enrich individual traders or exploiters while the burden of empire is borne by the people at home.

In the British Empire the name of "Crown Colonies" is given to those districts administered directly in the name of the king. Colonies of this type exhibit great differences among themselves, but they agree, however, in certain details. Each consists primarily of a great body of native

people, to which sometimes is added a staff of working *peons* from some other region—in plain language, imported serfs or slaves. The upper stratum consists of a relatively small group of traders, exploiters, miners, missionaries and officials, civil and military, engaged, for well or ill, in developing the resources of the country. Such colonies have been obtained in all sorts of ways, by purchase, by friendly negotiation, by reprisal, by wanton invasion and incidental conquest. An invasion of any kind produces disorder, disorder demands the presence of troops, occupation must be permanent to keep order, and the final result in annexation under the general plea of “manifest destiny,” or the needs of empire.⁷

At present, the last frontier is reached and every part of the world is under the actual or nominal supervision of some one of the great nations or world-powers. It is evident that no further changes can be made except by force of arms, by friendly negotiations or by efforts for freedom, peaceful or otherwise, from within. It is also evident that most of these colonies contribute to the expense as well as to the glory of the nation in occupation. They may be sources of revenue to individuals, but very rarely to the state. And the actual welfare of these regions is dependent on the acceptance of Article 3, which provides for the “Open Door,” that is, absolute freedom of commerce or at least equal liberty of trade to all nations. A pernicious feature of foreign occupancy is the establishment of “spheres of interest,” to the detriment of the nation in which they are delimited, and too often conflicting with one another.

So far as the present war is concerned, only the colonies of Germany are brought into question. Practically all of these have been seized by Great Britain during the war, a natural result of her control of the sea.

It will be quite impracticable to hold a *plébiscite* in these captured colonies to determine their future allegiance. For example, in German Samoa (Upolu) there exists a large body of natives numbering some thousands, a few dozen white people comprising German officials and

⁷ Referring to the occupation of Chitral in northern India by the British in 1895, Lord Morley thus describes the five stages of the road of “high Empire”:

“First you push into territories where you have no business to be, and where you had promised not to go; secondly, your intrusion provokes resentment, and, in these wild countries, resentment means resistance; thirdly, you instantly cry out that the people are rebellious and that their act is rebellion (this in spite of your own assurance that you have no intention of setting up a permanent sovereignty over them); fourthly, you send a force to stamp out the rebellion; and fifthly, having spread bloodshed, confusion and anarchy, you declare with uplifted hands to the heavens that moral reasons force you to stay, for if you were to leave, this territory would be left in a condition which no civilized power could contemplate with equanimity or composure. These are the five stages in the Forward Rake’s Progress.”

traders, an American hotel-keeper and trader, an American private banker or money-lender, two or three British lawyers, and finally a group of planters owning the cocoanut groves, most of these latter being naturalized German-Australians resident at Sydney. For the rest a few hundred serfs, negroids, brought from the Solomon islands.

A similar problem existed in Hawaii at the time of its annexation to the United States in 1900. The population of American or of North European descent, numbering about 12,000, owned and ruled the island, having overthrown the native queen some years before and established a nominal republic. The native Hawaiians numbered about 35,000. There were also about 20,000 Portuguese. Largely in a state of semi-servitude as laborers on the sugar plantations were about 60,000 Japanese and 25,000 Chinese, besides Coreans and Polynesians. Under a *plébiscite* the Hawaiians would mostly have opposed annexation. The Europeans generally favored it, but the final decision could hardly have been left to the illiterate majority on the plantations.

We must therefore fall back on the simple denial of the right of conquest even of colonial dependencies. The German colonies seized during the war should revert, unless, as a result of negotiation, some friendly exchanges can be made. Some such readjustments might seem to be possible and desirable.

It is certainly not wise to deprive a nation which has its heart set on colonial control of all opportunity to experiment with it. Colonial experience on a large scale tends to reduce the pressure of militarism at home, though at the same time expanding the demands of the military group. In time also it teaches the art of administration, which is apparently to be learned mainly through failure. The ultimate lesson seems to be that the only cement which really binds an empire together is the bond of freedom. Government which rests on force alone becomes ultimately brutal. This saying is credited to Cavour:

We can do anything with bayonets except to sit on them.

Provision might be made in international law for some form of condemnation of territory needed for purposes of civilization and held by recalcitrant tribes. But such right of condemnation should not be assumed by a powerful nation as against a weaker one. If necessity exists at all, it is a sort of community interest, in which any action taken should be a joint enterprise of the nations concerned. The position of the United States in regard to the Canal Zone in Panama would have been stronger if the approval of the great states of South America had been secured before action was taken.

In some of the more difficult of the problems involved in the adjustment to follow the war (those concerning Constantinople, Macedonia, Armenia, Mesopotamia, Syria, Persia, the Congo) it may be found

profitable or necessary to form international commissions of control. These would have their difficulties, but the purpose being fair play, the embarrassments would be relatively unimportant. The main thing is that modern methods of open conference should supersede traditional diplomacy.

V. CONCLUSION

We may now amplify Article I.

No right of conquest shall be recognized and no military necessity to the prejudice of neutral people or of neutral nations. No annexation or transfer of territory shall be made by force as a result of war or conquest. In case a problem of transfer of allegiance should concern a homogeneous civilized district accustomed to self-government by plébiscite, no transfer shall be made except in accordance with the will of the people, expressed in the secret ballot and without duress, the basis of suffrage being that already recognized in such region, preferably "one man, one vote." Whether any given district or province shall vote as a whole or by smaller units must depend on the actual conditions in the region concerned.

To the above we may add certain allied propositions. All extortions of indemnities by force of arms must be condemned as of the moral status of highway robbery.

Democratic control of foreign policy, involving the right of every people to keep out of war, would be a powerful influence towards international stability. Its logical outcome would be the abolition of a system of military conscription which has made an armed camp of the continent of Europe. All use of military intimidation as a political argument is fundamentally wrong because opposed to security and progress. Science is human experience tested and set in order. Science decries every influence which works adversely to human welfare, impairing abundance of life.

In so far as the propositions here set forth are sound, they represent "positive law" as defined by Grotius, that sequence of cause and effect which is inherent in the nature of human relations and which forms the solid basis of International Law. "Voluntary Law," whether the result of democratic agreement of the people or diplomatic deals of autocratic rulers, can never attain equal solidity or have equal binding force.

Finally, the success of any plan for durable peace must rest on the acceptance in good faith of Article 9 of the "Minimum Program." This provides for the abolition of secret treaties, with the permanent elimination of tortuous wrangling diplomacy and methods of mediavalism.

THE PROGRESS OF SCIENCE

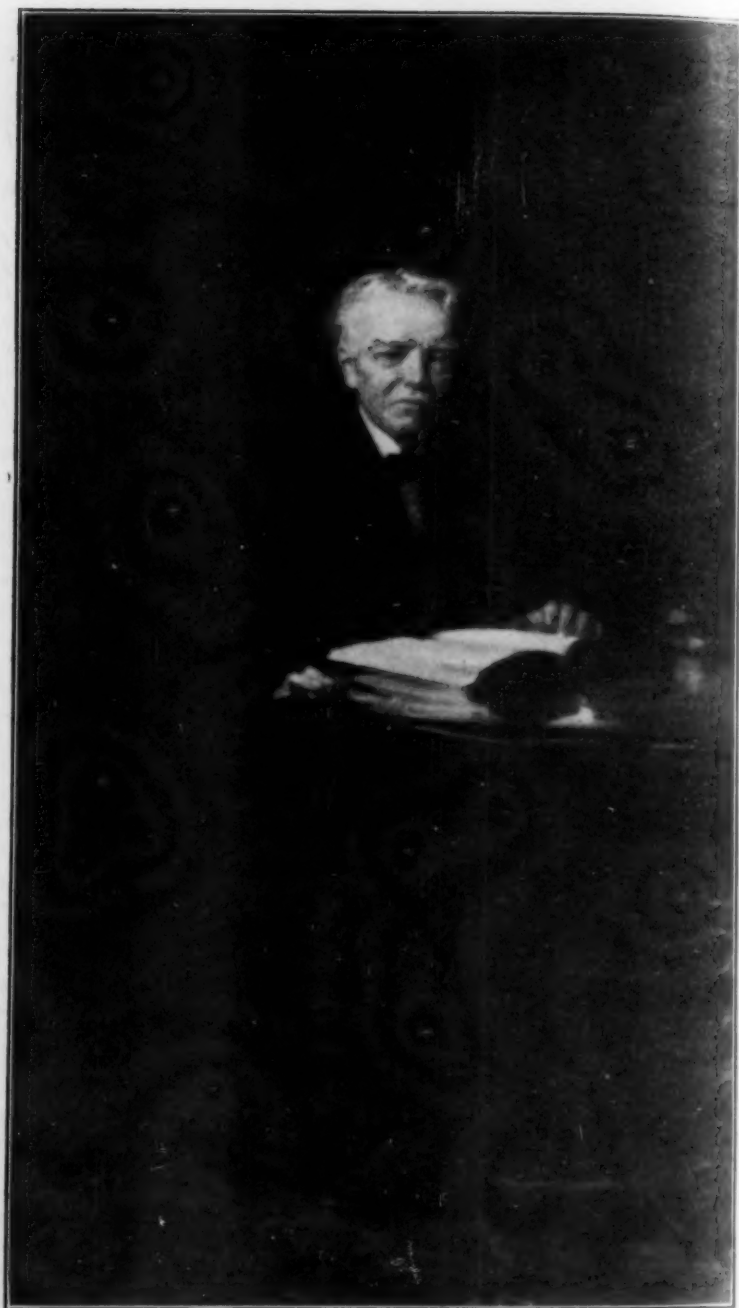
THE NEGLECT OF SCIENCE IN GREAT BRITAIN

A NUMBER of leading British men of science have united in signing a memorial protesting against the national neglect of science. They include Lord Rayleigh, Sir William Crookes, Sir William Ramsay, Sir William Osler and thirty-two others whose names carry great weight. The memorial urges that Great Britain has suffered checks since the war began, due directly as well as indirectly to lack of knowledge on the part of legislators and administrative officials of the ascertained facts and principles of science. Not only the highest ministers of state are ignorant of science, but the same defect runs through almost all the departments of the civil service; it is nearly universal in the House of Commons and is shared by the general public, including a large proportion of those engaged in industrial and commercial enterprises. The only exceptions are the navy and the medical service of the army, in which results have been achieved by men who have had a scientific training.

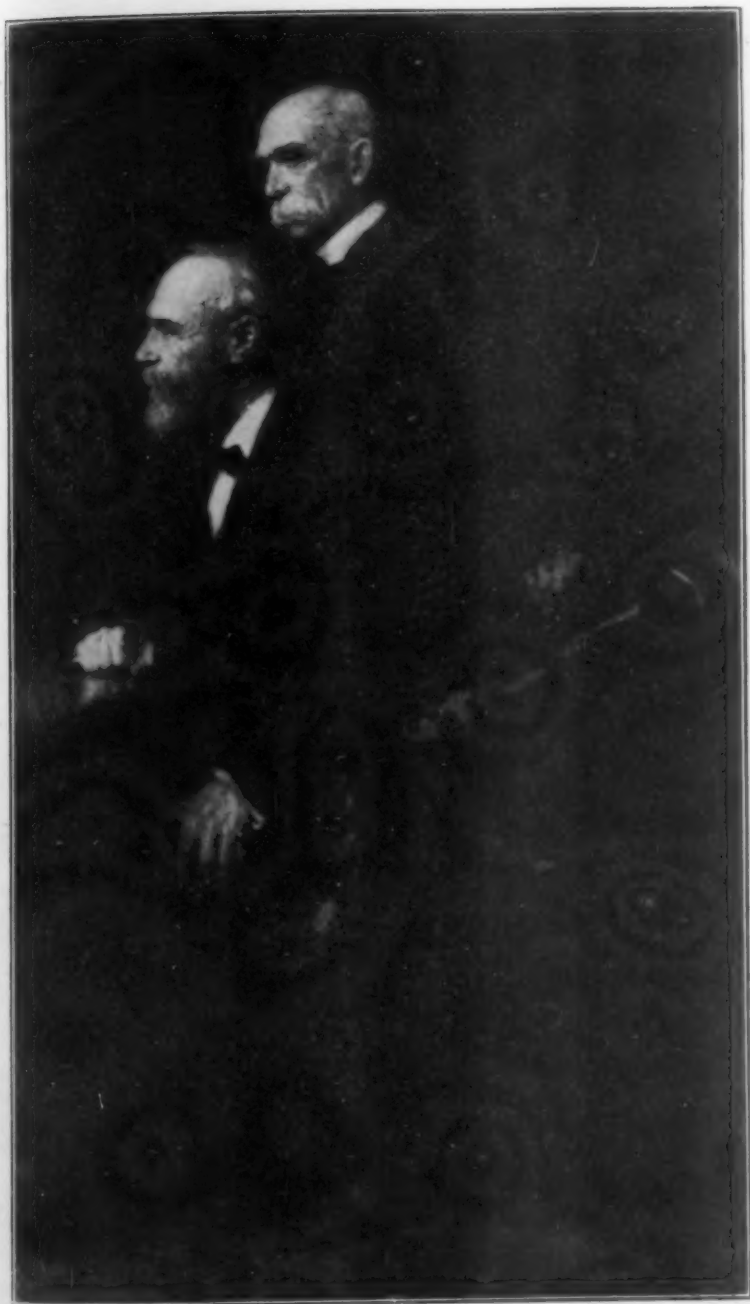
It is said that success now and in the difficult time of reorganizing after the war depends largely on the possession by leaders and administrators of scientific method and the scientific habit of mind. They must have knowledge and the habit of promptly applying known means to known needs. This can only be effected by a great change in the education of the class from which officials are drawn. The education of the democracy would follow a change in the education of the wealthy classes. It is pointed out that at present the methods of the old vested interests have retained their dominance at least as far as the ancient universities and the great schools are con-

cerned. At Cambridge, but four colleges are presided over by men of scientific training, at Oxford, not one. Of the thirty-five largest and best-known public schools, thirty-four have classical men as masters, none has a scientific man. The examinations for entrance into Oxford and Cambridge and for appointments in the civil service and in the army are such as to encourage the neglect of the study of the natural sciences and to some extent to encourage an indifferent not to say a contemptuous attitude towards them. The memorial urges the electors to insist that candidates for their suffrages should pledge themselves to aid by legislation in bringing about a drastic reform in the scheme for examinations in all the public services, a reform which it is claimed is vital to the continued existence of Great Britain as a great power.

A scientific man used to dealing with things as they are is probably a better legislator or administrator than a lawyer used to dealing in words and tradition. But expertness in science does not make a man omniscient or always wise in other directions. To take a trivial example, these thirty-six distinguished men of science blame a member of the government for not knowing that glycerine can be obtained from lard, but in the preceding paragraph they say that Lord Playfair is the only trained man of science who has been a cabinet minister, whereas he never was a cabinet minister. Sir William Crookes's opinion as to ghosts is not valuable. Sir William Ramsay doubtless regards Professor Ostwald's views on the conduct of the war as extremely foolish, and Professor Ostwald in turn doubtless looks on Sir William Ramsay's publications regarding the permanent sub-



PROFESSOR JOSIAH ROYCE, THE LATE PROFESSOR WILLIAM JAMES AND PROFESSOR GEORGE HERBERT PALMER. This painting of the three distinguished professors of philosophy of Harvard University by Mrs. Winifred Ruber will probably be purchased



by a group of alumni for presentation to the university. Professor Royce is seated on the left; Professor James is seated on the right; Professor Palmer is standing.

jection of Germany is beyond measure absurd.

There is no reason to suppose that the study of the classical languages is carried to excess in the United States, though a great deal of time is doubtless wasted in our schools on the elements of languages which are never learned or used. The classical curriculum dominates the German gymnasium more completely than it does the English public school. The number of people who can read Latin in Germany is far greater than the number in England, but in equal measure the number trained for research work in science is greater. According to Professor Vignon, of Lyons, there are for each 1,000 chemists in Germany 28 in France and 24 in England. What both Great Britain and the United States can learn from Germany is not so much substituting one kind of memory work for another in the schools and in civil service examinations, as the appreciation of the supreme value of research and the importance of depending on the expert in the field in which he is competent.

RECENT EXPERIMENTS IN AERODYNAMICS

THE Smithsonian Institution has just issued and sends us an abstract of an illustrated pamphlet containing a series of technical reports on experiments recently conducted in the wind tunnel for aerodynamics at the Massachusetts Institute of Technology, at Boston, Mass.

In writing on this wind tunnel itself, J. C. Hunsaker, assistant naval constructor, U. S. N., and instructor of aeronautics at the Institute, says that since it is difficult to carry on full scale experiments to investigate the aerodynamical characteristics of a proposed air-craft design, tests are made on small models, as in naval architecture. The experiments are further simplified by holding the models stationary in an artificial current of air with a maximum wind speed from 34 to 40 miles an hour, instead of towing

them at high speeds through still air to simulate actual flying conditions.

After a study of the principal aerodynamical laboratories of Europe, it was decided to reproduce at Boston the four-foot diameter wind tunnel of the National Physical Laboratory of Teddington, England, together with the aerodynamical balance and instruments used there for measuring velocity. In this connection the director of the English laboratory generously presented the detailed plans of the complete installation to the Massachusetts Institute of Technology. Mr. Hunsaker describes the wind tunnel, the aerodynamical balance, and explains some of the experiments and principles involved.

The second article of the series comprises notes on the dimensional theory of wind tunnel experiments, by Edgar Buckingham, of the U. S. Bureau of Standards, who defines the theories and principles involved, and suggests standardization of the methods employed.

In another report Mr. Hunsaker discusses the most common and convenient form of pressure anemometer, known as the Pitot tube, an instrument used in calculating the wind velocity from the pressure differences. He also describes the construction of an inclined manometer, a form of pressure gauge, used in the experiments.

Messrs. H. E. Rossell and D. W. Douglas report on their experiments concerning the adjustment of the velocity gradient across a section of the tunnel. Since in wind tunnel experiments it is essential that the velocity of the air striking different parts of the model under test, shall be the same, it was necessary after developing precise methods for measuring the velocity, to explore the cross-section of the tunnel to detect variations in velocity from point to point. The results of their experiments and the effects secured by the adjustment of a honey-comb grating, which straightened out the flow of air, are recorded.

Tests of the characteristic curves for

wing sections are discussed by Messrs. H. E. Rossell, C. L. Brand, and D. W. Douglas. They experimented with and tested the aerodynamical constants published by the British Advisory Committee for Aeronautics for wing profile R.A.F. 6, and found the results to be sufficiently precise for purposes of aeroplane design.

J. C. Hunsaker discusses stability of steering of a dirigible, citing some of his experimental tests with a wooden model of a dirigible hull fitted with rudders and fins in accordance with regular practice. It is now possible to base the design of fin and rudder area upon his data instead of "rule of thumb." His experiments proved that with the size rudder and fin fitted (7.79 and 3.47 sq. inches), the ship could be held on its course by the use of not more than $16\frac{1}{2}$ degrees of rudder. The importance of a vertical rudder was proved, but it was found impossible in practice to give sufficient vertical fin area to hold the ship on its course without the use of the helm.

The pitching and yawing moments on a model of a Curtiss aeroplane chassis and fuselage, complete with tail and rudder, but without wings, struts or propeller are set forth in an article by Messrs. Hunsaker and Douglas. Swept back wings are discussed by Messrs. Rossell and Brand, who maintain that with a sweep back of ten degrees an appreciable righting moment may be expected without change in any of the other aerodynamical properties of the straight wing.

In order to ascertain whether the righting moment secured by swept back wings as investigated by Messrs. Rossell and Brand, could be better obtained by another method, Messrs. Hunsaker and Douglas experimented with dihedral angle wings. They maintain that the dihedral angle wings afford better results than the swept back wings, and since the former are built much more easily, it is believed that the dihedral is of more value for pur-

poses of lateral stability. Attention is called to the fact that the "Langley aerodromes" built by the late Secretary of the Smithsonian Institution, were equipped with dihedral angle wings inclined upwards about six degrees. The last article is by J. C. Hunsaker and deals with critical speeds for flat discs in normal wind.

LONG-RANGE WEATHER FORECASTS

THE chief of the U. S. Weather Bureau has sent us a statement to the effect that in the opinion of the bureau a new system of long-range weather forecasting, which has been widely discussed recently, is quite fallacious. The new system is said to be based on the spottedness of the sun and rifts and shafts of solar radiation. In the opinion of the Weather Bureau it belongs in the same class with other methods of long-range weather forecasting based on lunar, planetary, magnetic and astrological considerations. None of these systems has any scientific value.

During the past few years the Weather Bureau has received full specifications concerning all the essential details of this particular system. The alleged discovery is, therefore, fully known to the Weather Bureau and has been carefully studied and examined by its scientific staff. Moreover, other scientific men of international reputation now connected with the strongest institutions of the world engaged in astronomical research, and conducting investigations into solar and terrestrial physics, have also passed upon these new theories. These authorities are in accord that the deductions and conclusions drawn from the solar conditions on which the new system is based are unwarranted.

When the disk of the sun is minutely examined with powerful telescopes, or when it is photographed with the aid of the modern spectroheliograph, the surface presents a characteristic spotted appearance which undergoes slight changes from day to day, and greater

changes with longer intervals of time, depending upon the well-known rotation of the sun upon its axis and the periodic recurrence of the sunspot maxima and minima. These and certain well-known related phenomena are now put forward as the basis of a new science which will make possible forecasts of the weather far in advance. That these features of solar activity, however, actually should control and determine the daily changes and sequence of weather conditions in any definite or direct and consequential manner, is quite impossible. Solar phenomena of the kind described do not have any direct influence upon the weather at any particular time and place, and can not be made the basis of any forecasts whatsoever.

The alleged discovery is only one of a number of similar schemes which are continually being put forward. In some cases the advocates assert that they can forecast the weather for weeks or months in advance, and in others they state that they have found means of producing rain artificially, of preventing hail, and in other ways of interfering with and controlling atmospheric phenomena. These pretensions meet with a certain credence because there are a number of people who still cling to the ancient belief in the influence of the moon on the growth and development of crops, and to the idea that the weather conditions depend upon planetary and astrological combinations. In consequence the Weather Bureau has been called upon from time to time to caution the general public against putting faith in these so-called discoveries.

The U. S. Weather Bureau is the authorized agency of the government to collect meteorological observations and make and issue weather forecasts and warnings. Every important nation of the world has a similar organization and all use essentially the same methods. All these organizations condemn and disprove the methods and theories of those who assert that they are able to predict the weather for any considerable period in advance.

SCIENTIFIC ITEMS

WE record with regret the death of Dr. Harry Clary Jones, professor of physical chemistry in the Johns Hopkins University; of Theodore Pergande, of the Bureau of Entomology; of Wells Woodbridge Cooke, of the Biological Survey; of John Wesley Judd, formerly professor of geology and dean of the Royal College of Science, London, and of Ernst Mach, emeritus professor of the history and theory of inductive science at Vienna.

DR. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, gave the William Ellery Hale Lectures at the meeting of the National Academy of Sciences in April. The subject was "The Origin and Evolution of Life on the Earth."—Dr. George Sarton, who is now lecturing in the United States on the history of science, the former editor of *Isis*, an international review devoted to the philosophy and history of science, published in Belgium, but discontinued during the war, has been awarded the Prix Binoux by the Paris Academy of Sciences.

APPROPRIATIONS amounting to \$1,200,000 have recently been made by the Rockefeller Foundation. To the Rockefeller Institute for Medical Research is given \$1,000,000 for additional endowment needed in connection with the Department of Animal Pathology, recently established near Princeton, N. J. To the Rockefeller Institute for Medical Research, \$25,000 goes for the cost of medical work at the seat of war in Europe. Most of this appropriation will be used for the support of the research and hospital work being conducted by Dr. Alexis Carrel in France. The China Medical Board receives \$125,000 for the purchase of additional property adjoining the Union Medical College in Peking. The international committee of the Young Men's Christian Association receives \$50,000 in support of the work in the military prison camps of Europe.